State of Maine

Department of Transportation
Bridge Program - Geotechnical
16 State House Station
Augusta, Maine 04333-0016

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Addendum #1 to Soils Report 2011-29

To:	T. McAuliffe, McFarland Johnson, T. Kendrick, McFarland Johnson
From:	Laura Krusinski, MaineDOT
Cc:	Mark Parlin, MaineDOT, file
Subject:	Addendum #1 to "Preliminary Geotechnical Design Report for the Replacement of Ohio Street Bridge Over Interstate 95, Bangor Maine" Soils Report No. 2011-29
Date:	June 26, 2019; Revised July 8, 2019
WIN:	18722.00
Town:	Bangor

The following changes are made to the Preliminary Geotechnical Design Report for the Replacement of Ohio Street Bridge Over Interstate 95, Bangor Maine" Soils Report No. 2011-29:

1. Throughout the document, replace the WIN 16682.00 with *WIN 18722.00*

2. Throughout the document replace the Fed No. IM-1668(200)E with *the Project No. STP-1872(200).*

3. Replace the reference in paragraph 1 on page 1, and in last paragraph on page 9 with: *AASHTO LRFD Bridge Design Specification, Eighth Edition, 2017.*

4. Replace the last sentence in paragraph 3 on page 1, in paragraph 5 on page 2, in paragraph 2 on page 10 and in paragraph 6 on page 11 with: *"For footings on soil, the location of the resultant of the reaction forces at the strength limit state, based on factored loads, shall be within the middle two-thirds (2/3) of the base width"*

5. Replace the last sentence in paragraph 3 on page 10 with: *"The overall global stability of Abutments No. 1 and 2 and the respective approach fills were evaluated. The resulting factors of safety exceed 1.5 as required by LRFD 11.6.2.3. A factor of safety of 1.5 corresponds to an LRFD resistance factor of 0.65."*

6. Strike the second to last sentence of the last paragraph on page 11 beginning with "The overall global stability…"

7. Add the following paragraph to the Geotechnical Design Summary and to page 10*: Semi-integral abutments should be designed for active earth pressure over the abutment height and a uniform pressure distribution due to the height of soil behind the superstructure. The superstructure backwall should typically be designed for full passive pressure. In designing the abutment stem for active pressure, a Rankine active earth pressure coefficient, K_a, of 0.31 (assuming a level backfill) is recommended. In designing the superstructure end diaphragm for passive earth pressure, the Coulomb state is recommended. Experience has shown that the use of the Coulomb passive earth pressure coefficient of 6.89 (assuming a level backfill) may result in uneconomical designs if thermal movements are small. For this reason, consideration may be given to using a Rankine passive earth pressure coefficient (K_p) of 3.25 (assuming a level backfill), when designing the superstructure end diaphragm.*

8. Replace the first two sentences of paragraph 2 on page 11 with*: Backfill within 10 feet of the abutments and wingwalls and side slope fill shall conform to MaineDOT Specification 703.19, Granular Borrow for Underwater Backfill. This gradation specifies 7 percent or less of material passing the No. 200 sieve."*

9. Replace the second sentence of paragraph 7 on page 2 and the second sentence of Section 7.3 on page 12 with: *"If barriers are not used, the abutment, pier or wingwall shall be designed for an equivalent static force of 600 kips assumed to act in the direction of zero to 15 degrees with the edge of the pavement in a horizontal plane, at a distance of 5.0 ft above ground."*

10. Replace Sheet 2 – Boring Location Plan with the attached Sheet 2 - Boring Location Plan which has been updated with the current abutment, wingwall and pier details.

11. Replace Sheet 3 – Interpretive Subsurface Profile with the attached Sheet 3 - Interpretive Subsurface Profile which has been updated with the current abutment, wingwall and pier details.

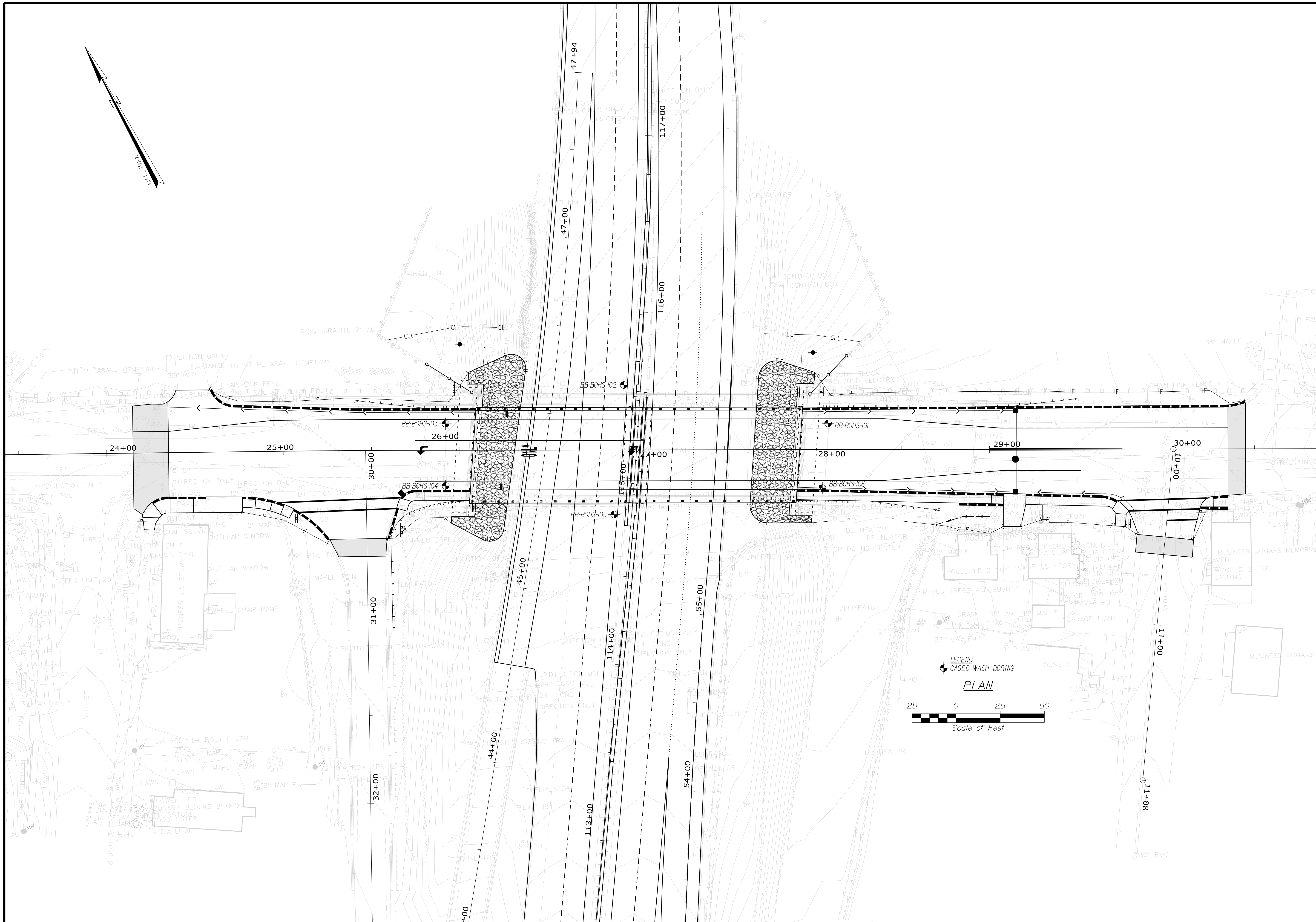
12. Replace Sheets 4 and 5 – Boring Logs with the attached Sheets 4 and 5 – Boring Logs which has been updated with the Project Number.

13. Add the attached Global Stability Analyses to Appendix C – Calculations

Attachments

Sheet 2 – Boring Location Plan
Sheet 3 – Interpretive Subsurface Profile
Sheets 4 and 5 – Boring Logs
Calculations - Global Stability Analyses

Filename: ...\00\GEOTECH\MSTA\002_BLP1.dgn Division: GEOTECH Username: Terry.White Date: 7/1/2019



STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-1872(200)

WIN 018722.00

BRIDGE NO. 5790

BRIDGE PLANS

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	KRUSINSKI	
DESIGN3-DETAILED3	T. WHITE	APR 2019
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

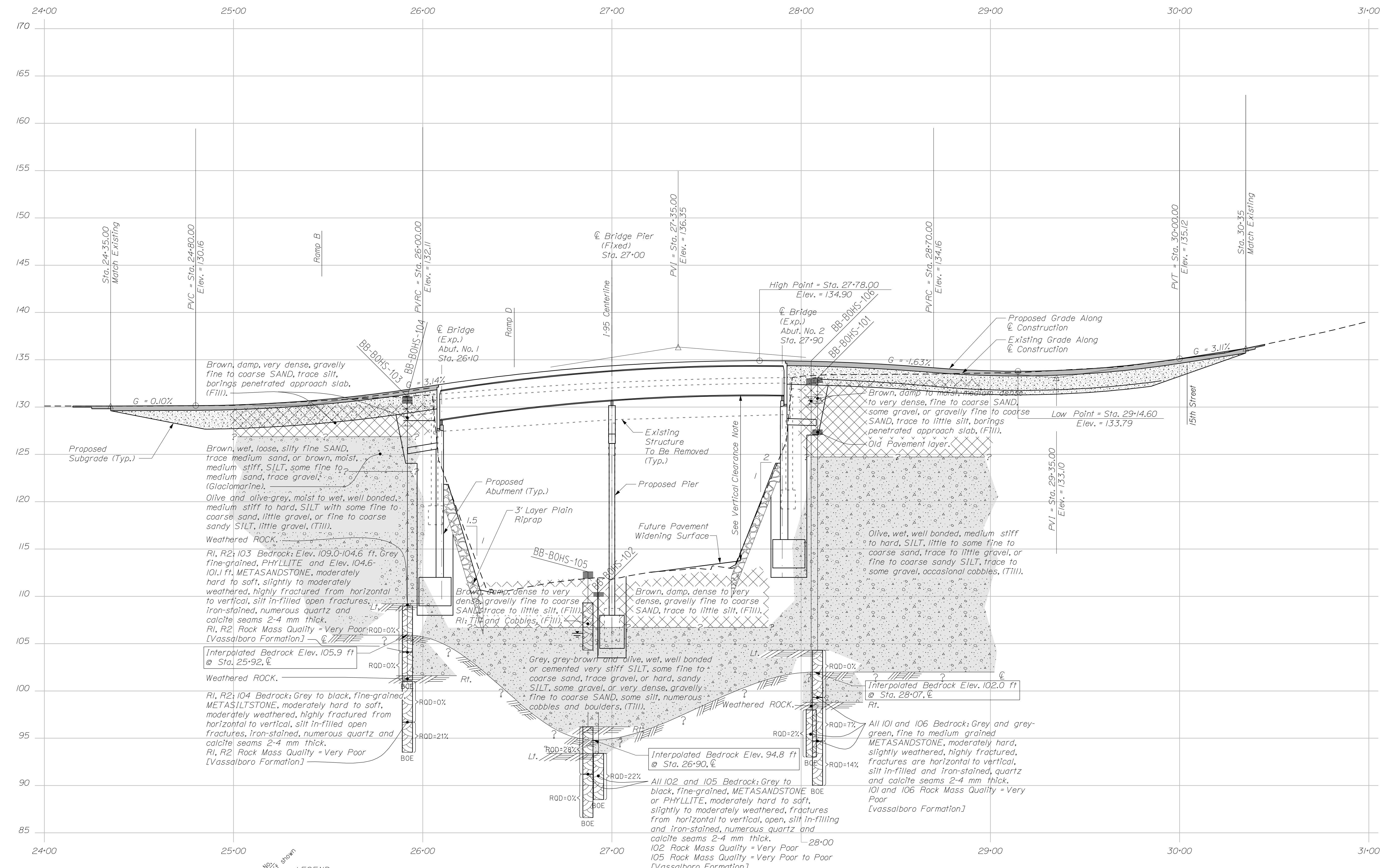
P.E. NUMBER

DATE

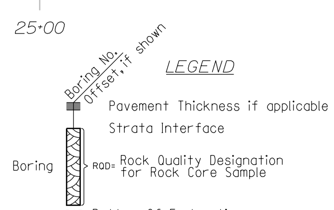
OHIO STREET BRIDGE
INTERSTATE 95
BANGOR PENOBSCOT COUNTY

BORING LOCATION PLAN

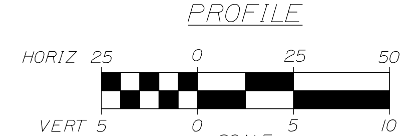
SHEET NUMBER
2
OF 5



LEGEND



PROFILE



Note: This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-1872(200)

WIN 018722.00

BRIDGE PLANS

BRIDGE NO. 5790

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	L.KRUSINSKI	
DESIGN3-DETAILED3	T.WHITE	APR 2019
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

OHIO STREET BRIDGE
INTERSTATE 95
BANGOR PENOBSCOT COUNTY

INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER

3

OF 5

Filename: ...\MSTA\004_BORING LOGS1.dgn   Division: GEOTECH   Username: Terry.White   Date:7/1/2019

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-103
WIN: 18722.00

Driller:	MaineDOT-Northern Test Boring	Elevation (ft.)	131.1	Auger ID/OD:	5" Solid Stem
Operator:	Giguere/Giles-Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C-Diedrich D-50	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/20/09-5/20/09	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	25+91.9, 15.1 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in. Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows
						SSA
1D	3.6/3	1.00 - 1.30	50(3.6")	---		
2D	24/24	5.00 - 7.00	2/3/3/2	remark below		
3D	24/20	10.00 - 12.00	5/9/8/12	remark below		30
						16
MV		12.00 - 12.00	Would not push			15
						23
						29
4D	24/22	15.00 - 17.00	8/10/12/12	22	28	OPEN HOLE
MV		17.00 - 17.00	Would not push			
5D	22.8/18	20.00 - 21.90	11/13/13/50(4.8)	26	33	
R1	58.8/58.8	22.10 - 27.00	RQD = 0%			NQ-2
R2	36/27	27.00 - 30.00	RQD = 0%			

Elevation (ft.)	Visual Description and Remarks	Depth (ft.)	Laboratory Testing Results/AASHTO and Unified Class
130.70	PAVEMENT.	0.40	
129.80	Brown, damp, very dense, gravelly fine to medium SAND, (Fill).	1.30	
128.00	Concrete with re-bar layer.	3.10	
126.60	Brown, damp, very dense, gravelly fine to medium SAND, (Fill).	4.50	
122.10	Brown, wet, loose, silty fine SAND, trace medium sand, (Glaciomarine).	9.00	G#246298 A-4, SM WC=17.5%
	Olive, wet, very stiff to hard, SILT some fine to coarse sand, little gravel, (Till). Roller coned ahead to 15.0' bgs.		G#246299 A-4, SM WC=12.3%
	Failed 16x32 mm vane attempt.		
	Similar to above.		G3246300 A-4, ML WC=10.9%
	Failed 16x32 mm vane attempt.		
109.20	Similar to above. Weathered Rock in spoon tip.	21.90	
109.00	Weathered Bedrock	22.10	
104.60	Top of Bedrock at Elev. 109.2'. R1 Bedrock: Grey, fine-grained PHYLLITE (22.1' to 26.5' bgs), moderately hard to soft, slightly to moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick, one calcite seam 2 cm thick at 24.7' bgs, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 22.1-23.1' (3:05) 23.1-24.1'(3:50) 24.1-25.1' (5:30) 25.1-26.1' (6:06) 26.1-27.0' (6:24) 100% Recovery Core Blocked	26.50	
101.10	R2 Bedrock: Grey, fine-grained METASANDSTONE (26.5' to 30.0' bgs), moderately hard to soft, slightly to moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick, Rock Mass Quality is Very Poor. [Vassalboro Formation] R2:Core Times (min:sec) 27.0-28.0' (3:55) 28.0-29.0' (3:55) 29.0-30.0' (8:18) 75% Recovery Core Blocked	30.00	
	Bottom of Exploration at 30.00 feet below ground surface.		

Remarks:

MaineDOT sampled 1D thru 3D then rig broke down. Using hammer efficiency factor of 0.84, the N60 SPT Blow Counts Are: 2D=8, 3D=24

NTB completed the boring with hammer #283 and hammer efficency factor of 0.76.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1
Boring No.: BB-BOHS-103

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-104
WIN: 18722.00

Driller:	Northern Test Boring	Elevation (ft.)	131.0	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	Diedrich D-50	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/13/09; 12:00-15:45	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	25+91.9, 20.1 Rt.	Casing ID/OD:	NW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in. Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows
						SSA
1D	24/24	5.00 - 7.00	3/3/3/3	6	8	
2D	24/22	10.00 - 12.00	11/6/12/10	18	23	30
						57
MV		12.00 - 12.00	Would not push			59
						67
						OPEN HOLE
3D	24/16	15.00 - 17.00	8/11/20/23	31	39	
4D	24/14	20.00 - 22.00	11/16/10/14	26	33	
5D	24/18	25.00 - 27.00	13/14/14/13	28	35	
R1	51.6/24	30.00 - 34.30	RQD = 0%			NQ-2
R2	38.4/36.4	34.30 - 37.50	RQD = 21%			

Elevation (ft.)	Visual Description and Remarks	Depth (ft.)	Laboratory Testing Results/AASHTO and Unified Class
130.40	PAVEMENT.	0.60	
129.10	Brown, damp, gravelly fine to coarse SAND, trace silt.	1.90	
128.50	Concrete with re-bar layer.	2.50	
127.50	Brown, damp, gravelly fine to coarse SAND, trace silt.	3.50	
123.00	Brown, moist, medium stiff SILT, some fine to medium sand, trace gravel (Glaciomarine).	8.00	G#246301 A-4, ML WC=28.4%
	Olive-grey to grey, moist to wet, well bonded, very stiff to hard, fine to coarse sandy SILT, little gravel, (Till).		G#246302 A-4, ML WC=11.3%
	Failed 16x32 mm vane attempt.		
			G#246303 A-4, SM WC=10.3%
101.60	Olive-grey to grey, moist to wet, well bonded, very stiff to hard, fine to coarse sandy SILT, little gravel, (Till).	29.40	
101.00	Weathered ROCK. Roller Coned ahead to 30.0' bgs.	30.00	
93.50	Top of intact Bedrock at Elev. 101.0'. R1 and R2 Bedrock: Grey to black, fine-grained METASILTSTONE, moderately hard to soft, moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams up to 2 cm thick and numerous after 34.3' bgs (R2), Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 30.0-31.0' (6:00) 31.0-32.0' (5:30) 32.0-33.0' (5:40) 33.0-34.0' (8:24) 34.0-34.3' (3:07) 45% Recovery Core Blocked R2:Core Times (min:sec) 34.3-35.0' (2:00) 35.0-36.0' (3:02) 36.0-37.0' (3:43) 37.0-37.5' (3:06) 95% Recovery Core Blocked	37.50	
	Bottom of Exploration at 37.50 feet below ground surface.		

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1
Boring No.: BB-BOHS-104

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-102
WIN: 18722.00

Driller:	Northern Test Boring	Elevation (ft.)	110.4	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	M. Moreau	Rig Type:	Diedrich D-50 Trailer	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/20/09-5/20/09	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	26+92.9, 36.8 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.68		Hammer Type:	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in. Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows
						SSA
1D	24/12	2.00 - 4.00	6/18/18/30	36	41	
2D	9.6/7	5.00 - 5.80	36/50(3.6")	---		OPEN HOLE
MD	1.2/0	10.00 - 10.10	54(1.2")	---		
3D	1.2/1	15.00 - 15.10	100(1.2")	---		
R1	58.8/48	17.00 - 21.90	RQD = 22%			NQ-2

Elevation (ft.)	Visual Description and Remarks	Depth (ft.)
109.60	PAVEMENT.	0.80
104.60	Brown, damp, dense, gravelly fine to coarse SAND, trace silt, (Fill).	5.80
	Grey-brown, cemented, very dense, gravelly fine to coarse SAND, some silt, with numerous cobbles and boulders, (Till). Refusal on spoon at 5.8' bgs. Roller Coned ahead to 10.0' bgs. in open hole.	
	Failed sample attempt.	
93.40	Gravel, trace silt, wash from very dense till with cobbles and boulders. Roller Coned ahead to 17.0'bgs. Drill attitude indicates Bedrock at 17.0' bgs.	17.00
92.40	Top of Bedrock at Elev. 93.4'. R1:Core Times (min:sec) 17.0-18.0' (4:37)	18.00
88.50	R1 Bedrock: Grey, fine-grained, METASANDSTONE (top one foot) and PHYLLITE (18.0' to 21.9' bgs), moderately hard, slightly weathered, fractures from horizontal to 45 degress, close, open with minor silt in filling and iron-staining, quartz seam 19.3-19.7', numerous quartz and calcite seams 2-4 mm thick, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) Con't 18.0-19.0' (5:58) 19.0-20.0' (7:56) 20.0-21.0' (6:43) 21.0-21.9' (5:16) 81% Recovery	21.90
	Bottom of Exploration at 21.90 feet below ground surface.	

Remarks:

Auto Hammer #149

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1
Boring No.: BB-BOHS-102

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-105
WIN: 18722.00

Driller:	MaineDOT	Elevation (ft.)	112.6	Auger ID/OD:	5" Solid Stem
Operator:	Giguere/Giles	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/20/09; 06:00-9:30	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	26+87.3, 36.5 Rt.	Casing ID/OD:	HW	Water Level*:	6.5' bgs.
Hammer Efficiency Factor: 0.84		Hammer Type:	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in. Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows
						SSA
1D	15.6/12	2.00 - 3.30	13/28/50(3.6")	---		
R1	60/4	3.30 - 8.30	RQD = N/A%			50 NQ-2
						13
						4
						10
						6
2D	24/17	8.30 - 10.30	10/8/9/13	17	24	26
						37
						44
						55
						69
						83
						47
3D	16.8/16.8	15.00 - 16.40	10/32/50(4.8")	---		68
R2	60/60	16.40 - 21.40	RQD = 28%			a40 NQ-2
R3	55.2/55.2	21.40 - 26.00	RQD = 0%			

Elevation (ft.)	Visual Description and Remarks	Depth (ft.)	Laboratory Testing Results/AASHTO and Unified Class
111.90	PAVEMENT.	0.70	
108.60	Brown, damp, very dense, gravelly, fine to coarse SAND, little silt.	4.00	G#246304 A-1-b, SM WC=4.9%
	R1:Fill, Till and Cobbles. R1:Core Times (min:sec) 3.3-4.3' (1:33) 4.3-5.3' (1:45) 5.3-6.3' (1:46) 6.3-7.3' (1:45) 7.3-8.3' (1:12) Put sample in cup.		
99.60	Olive, wet, well bonded, very stiff, SILT, some fine to coarse sand, trace gravel, cobbles, (Till).	13.00	G#246305 A-4, ML WC=12.4%
96.20	Grey, wet, cemented, hard, fine to coarse sandy SILT, some gravel, cobbles, (Till). Weathered Rock in spoon tip. a40 blows for 0.4'.	16.40	G#246306 A-4, SM WC=12.3%
86.60	Top of Bedrock at Elev. 96.2'. R2 and R3 Bedrock: Grey to black, fine-grained METASANDSTONE, moderately hard to soft, moderately weathered, moderately to highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick. Rock Mass Quality is Very Poor to Poor. [Vassalboro Formation] R2:Core Times (min:sec) 16.4-17.4' (5:44) 17.4-18.4' (3:35) 18.4-19.4' (3:40) 19.4-20.4' (3:47) 20.4-21.4' (2:50) 100% Recovery R3:Core Times (min:sec) 21.4-22.4' (3:48) 22.4-23.4' (3:15) 23.4-24.4' (4:55) 24.4-25.4' (4:17) 25.4-26.0' (4:12) 100% Recovery Core Blocked	26.00	
	Bottom of Exploration at 26.00 feet below ground surface.		

Remarks:

300# down pressure on core barrel.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1
Boring No.: BB-BOHS-105

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

STP-1872(200)

WIN 018722.00

BRIDGE NO. 5790

BRIDGE PLANS

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	L.KRUSINSKI	T.WHITE / APR 2019
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

OHIO STREET BRIDGE
INTERSTATE 95
BANGOR   PENOBSCOT COUNTY

BORING LOGS

SHEET NUMBER
4
OF 5

Filename: ...\MSTA\005_BORING LOGS2.dgn   Division: GEOTECH   Username: Terry.White   Date:7/1/2019

Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine
Boring No.: BB-BOHS-101
WIN: 18722.00

Driller:	Northern Test Boring	Elevation (ft.)	133.1	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	Diedrich D-50 Trailer	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/12/09; 06:45-11:30	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	28+08.6, 14.9 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
0	1D	15.6/10	0.50 - 1.80	37/37/50(3.6")	---		SSA	132.60
								131.30
								130.40
5	2D	24/18	5.00 - 7.00	12/43/16/11	59	75		127.60
								127.10
								125.10
10	3D	24/20	10.00 - 12.00	4/3/3/4	6	8	40	
							124	
							86	
							150	
							194	119.10
15	4D	24/20	15.00 - 17.00	10/13/20/20	33	42	OPEN HOLE	
	MV		17.00 - 17.00	Would Not Push				
20	5D	24/20	20.00 - 22.00	12/16/20/36	36	46		113.10
25	6D	24/16	25.00 - 27.00	8/9/19/25	28	35		
	R1	60/35	28.80 - 33.80	RQD = 0%			NQ-2	104.30
30								
	R2	55.2/40	33.80 - 38.40	RQD = 7%				
35								
	R3	56.4/56.4	38.40 - 43.10	RQD = 14%				
40								90.00
45								
50								

Visual Description and Remarks	Depth (ft.)	Laboratory Testing Results/AASHTO and Unified Class
PAVEMENT.	0.50	
Brown, damp, very dense, fine to coarse SAND, some gravel, little silt.	1.80	G#246294 A-1-a, SM WC=3.2%
Concrete layer with re-bar from 1.8-2.7' bgs.	2.70	
Similar to above.	5.50	
Old Pavement layer from 5.5-6.0' bgs.	6.00	
	8.00	
Olive, wet, mottled, medium stiff, fine to coarse sandy SILT, trace gravel, (Till).	14.00	G#246295 A-4, ML WC=19.8%
Olive, wet, well bonded, hard, SILT, some fine to coarse sand, trace to little gravel, (Till). Failed 16x32 mm vane attempt.	20.00	G#246296 A-4, ML WC=11.4%
Similar to above, but with occasional cobbles. Olive, wet, well bonded, hard, SILT, some fine to coarse sand, trace to little gravel, occasional cobbles, (Till).	28.80	G#246297 A-4, ML WC=11.0%
Top of Bedrock at Elev. 104.3'. R1, R2, R3 Bedrock: Grey, fine-grained METASANDSTONE, moderately hard, slightly weathered, highly fractured (core is largely friable), fractures are open, silt in-filled, numerous quartz and calcite seams 2-4 mm thick, less fractured from 34.3' to 36.8' bgs, highly weathered zone between 36.8' and 38.4' bgs, R3 is moderately fractured with fractures that follow bedding planes from horizontal to 45 degrees above horizontal, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 28.8-29.8' (2:36) 29.8-30.8' (3:35) 30.8-31.8' (3:06) 31.8-32.8' (4:02) 32.8-33.8' (3:02) 58% Recovery R2:Core Times (min:sec) 33.8-34.8' (2:50) 34.8-35.8' (2:05) 35.8-36.8' (2:50) 36.8-37.8' (4:55) 37.8-38.4' (2:06) 80% Recovery Core Blocked R3:Core Times (min:sec) 38.4-39.4' (2:55) 39.4-40.4' (3:22) 40.4-41.4' (3:03) 41.4-42.4' (3:40) 42.4-43.1' (2:45) 100% Recovery Core Blocked	43.10	
Bottom of Exploration at 43.10 feet below ground surface.		

Remarks:
Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1
Boring No.: BB-BOHS-101

Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine
Boring No.: BB-BOHS-106
WIN: 18722.00

Driller:	Northern Test Boring	Elevation (ft.)	133.0	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	Diedrich D-50	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/13/09; 06:45-11:30	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	28+05.3, 21.8 Rt.	Casing ID/OD:	NW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
0							SSA	132.45
								131.10
								130.00
5	1D	24/20	5.00 - 7.00	7/13/11/13	24	30		
								123.50
10	2D	24/18	10.00 - 12.00	6/8/8/6	16	20	62	
							55	
	MV		12.00 - 12.00	Would not push			98	
							132	119.50
							133	
15	3D	24/20	15.00 - 17.00	11/15/18/19	33	42	OPEN HOLE	
20	4D	24/19	20.00 - 22.00	8/8/14/15	22	28		
25	5D	24/18	25.00 - 27.00	7/17/11/9	28	35		
								104.50
30	6D	24/20	30.00 - 32.00	9/12/22/19	34	43		
								98.80
35	R1	60/43	35.00 - 40.00	RQD = 2%			NQ-2	98.00
40								93.00
45								
50								

Visual Description and Remarks	Depth (ft.)	Laboratory Testing Results/AASHTO and Unified Class
PAVEMENT.	0.55	
Brown, damp, gravelly fine to medium SAND, trace silt, (Fill).	1.90	
Concrete layer with re-bar from 1.9-3.0' bgs.	3.00	
Brown, moist, medium dense, gravelly fine to coarse SAND, little silt, (Old Pavement, Fill).	9.50	
Olive, wet, very stiff, fine to coarse sandy SILT, some gravel, (Till). Failed 16x32 mm vane attempt.	13.50	G#246307 A-4, SM WC=11.1%
Olive, wet, well bonded, very stiff to hard, SILT, some fine to coarse sand, little gravel, (Till). Olive, wet, well bonded, very stiff to hard, SILT, some fine to coarse sand, little gravel, (Till).	28.50	G#246308 A-4, ML WC=9.4% G#24630 A-4, ML WC=11.2%
Olive, wet, well bonded, hard, SILT, little fine to coarse sand, trace gravel, (Till). Cobble from 33.0-33.5' bgs.	34.20	G#246310 A-4, ML WC=14.4%
Weathered Rock. Roller Coned ahead to 35.0' bgs.	35.00	
Top of intact Bedrock at Elev. 98.0'. R1 Bedrock: Grey-green, fine to medium grained, METASANDSTONE, moderately hard, highly fractured with open fractures oriented from horizontal to vertical, very slight weathering, with minor silt in-filling and iron staining along fractures, one silt seam approximately 1-2 cm thick at 36.9' bgs, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 35.0-36.0' (3:00) 36.0-37.0' (4:30) 37.0-38.0' (4:00) 38.0-39.0' (2:55) 39.0-40.0' (2:40) 72% Recovery	40.00	
Bottom of Exploration at 40.00 feet below ground surface.		

Remarks:
Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1
Boring No.: BB-BOHS-106

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
STP-1872(200)
BRIDGE NO. 5790
WIN 018722.00
BRIDGE PLANS

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED		
CHECKED-REVIEWED		
DESIGN2-DETAILED2	L.KRUSINSKI	T.WHITE APR 2019
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

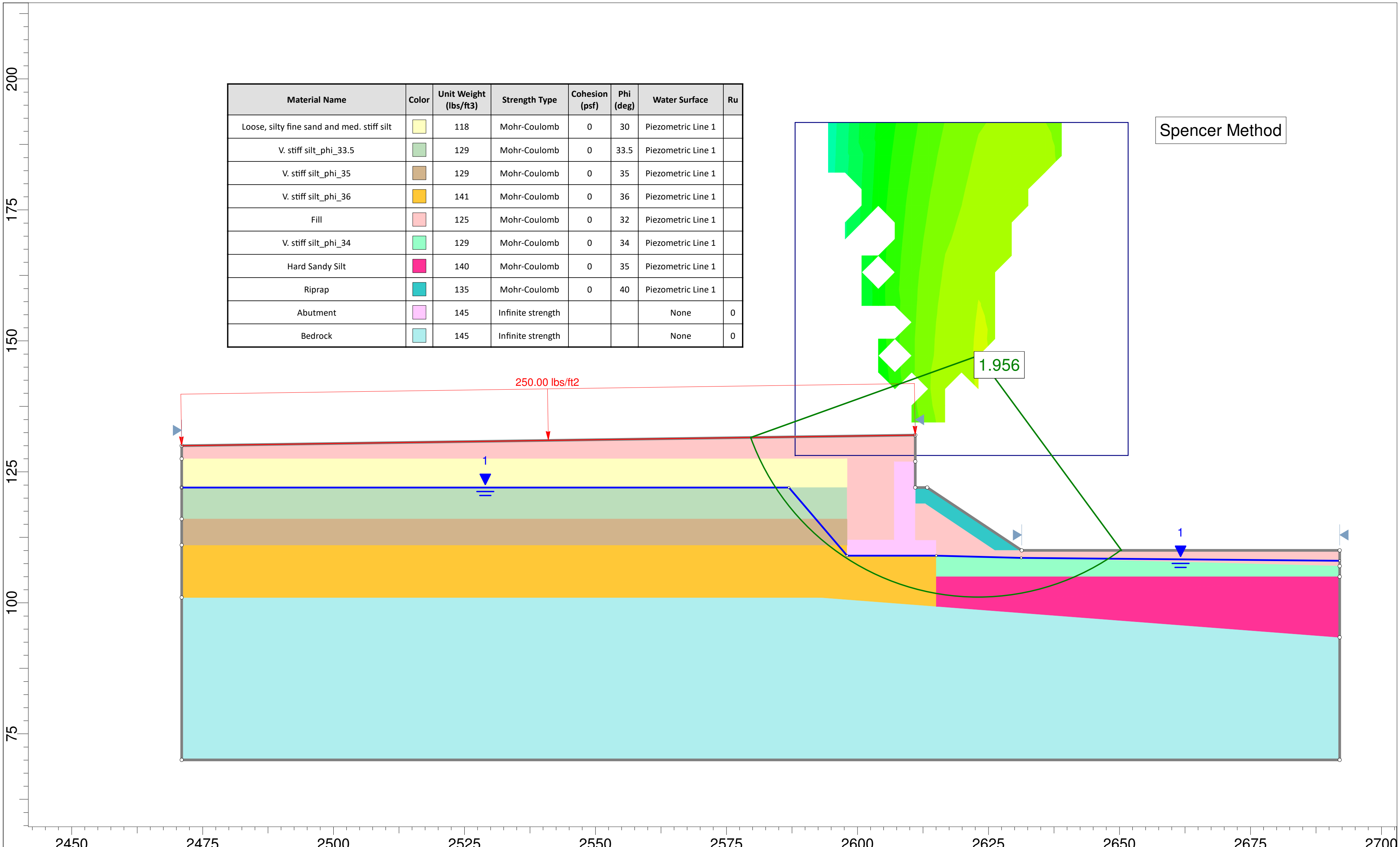
SIGNATURE
P.E. NUMBER
DATE

OHIO STREET BRIDGE
INTERSTATE 95
BANGOR PENOBSCOT COUNTY

BORING LOGS

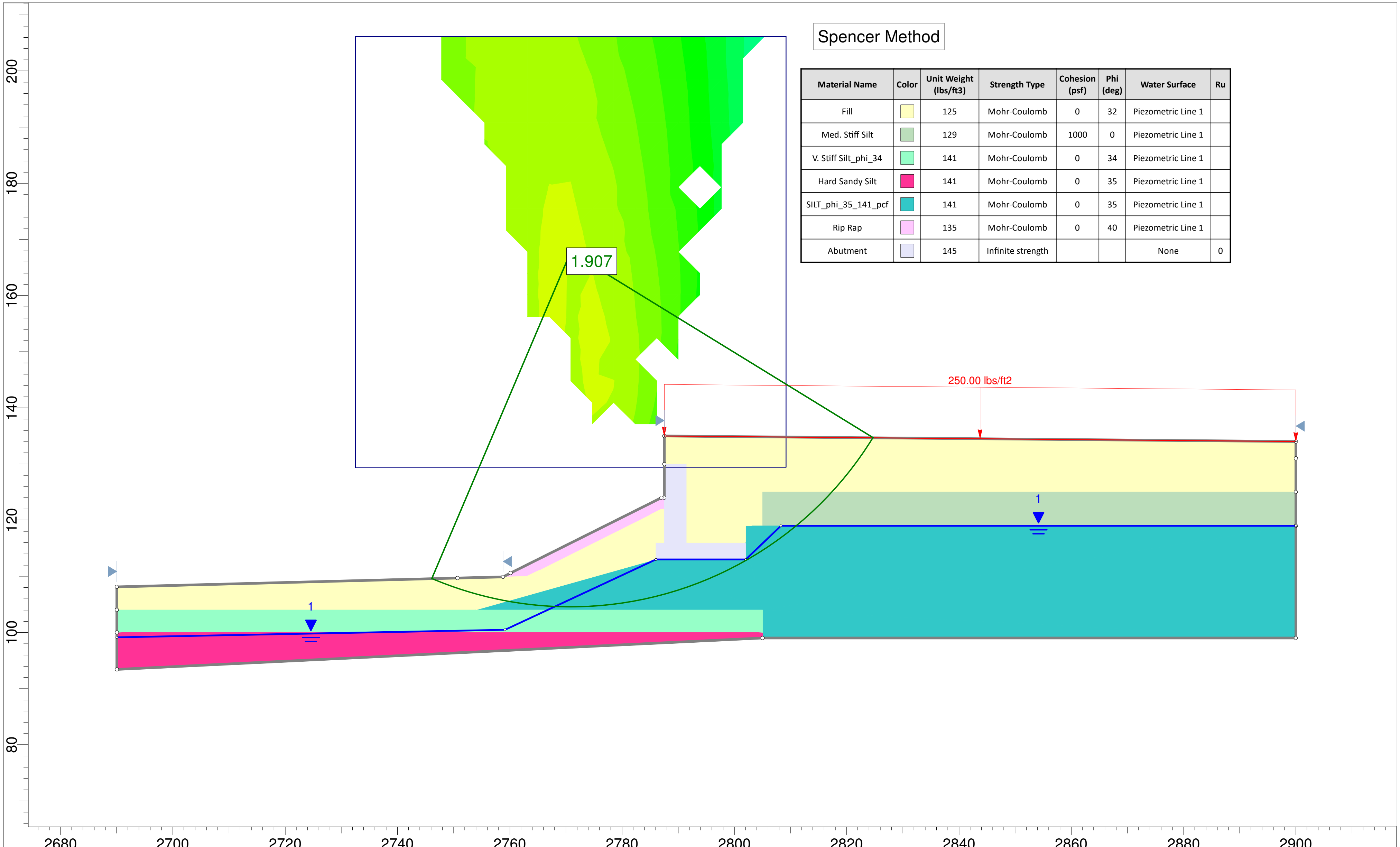
SHEET NUMBER
5
OF 5

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Loose, silty fine sand and med. stiff silt		118	Mohr-Coulomb	0	30	Piezometric Line 1	
V. stiff silt_phi_33.5		129	Mohr-Coulomb	0	33.5	Piezometric Line 1	
V. stiff silt_phi_35		129	Mohr-Coulomb	0	35	Piezometric Line 1	
V. stiff silt_phi_36		141	Mohr-Coulomb	0	36	Piezometric Line 1	
Fill		125	Mohr-Coulomb	0	32	Piezometric Line 1	
V. stiff silt_phi_34		129	Mohr-Coulomb	0	34	Piezometric Line 1	
Hard Sandy Silt		140	Mohr-Coulomb	0	35	Piezometric Line 1	
Riprap		135	Mohr-Coulomb	0	40	Piezometric Line 1	
Abutment		145	Infinite strength			None	0
Bedrock		145	Infinite strength			None	0



Project	Bangor Ohio St. Bridge		
Analysis Description	WIN 18722.00		
Drawn By A. Van Buskirk	*Scale* 1:304	*Company*	MaineDOT
Date 5/10/2019, 8:53:54 AM		*File Name*	18722 Bangor West Abutment_rev2.slim

SLIDEINTERPRET 6.029



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Fill		125	Mohr-Coulomb	0	32	Piezometric Line 1	
Med. Stiff Silt		129	Mohr-Coulomb	1000	0	Piezometric Line 1	
V. Stiff Silt_phi_34		141	Mohr-Coulomb	0	34	Piezometric Line 1	
Hard Sandy Silt		141	Mohr-Coulomb	0	35	Piezometric Line 1	
SILT_phi_35_141_pcf		141	Mohr-Coulomb	0	35	Piezometric Line 1	
Rip Rap		135	Mohr-Coulomb	0	40	Piezometric Line 1	
Abutment		145	Infinite strength			None	0

rocscience

SLIDEINTERPRET 6.029

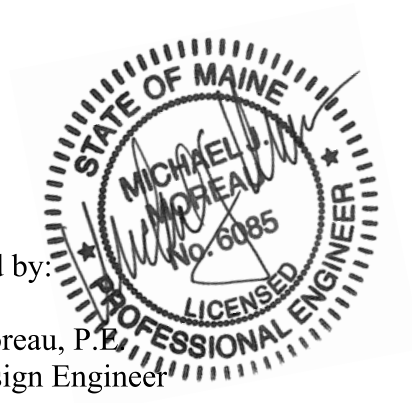
Project	Bangor Ohio St. Bridge		
Analysis Description	WIN 18722.00		
Drawn By	A. Van Buskirk	*Scale* 1:284	*Company* MaineDOT
Date	4/26/2019, 7:24:14 AM	*File Name*	18722 Bangor East Abutment_rev2.slim

MAINE DEPARTMENT OF TRANSPORTATION
BRIDGE PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

PRELIMINARY GEOTECHNICAL DESIGN REPORT

For the Replacement of:

OHIO STREET BRIDGE
OVER INTERSTATE 95
BANGOR, MAINE



Prepared by:

Michael J. Moreau, P.E.
Geotechnical Design Engineer

Reviewed by:

Laura Krusinski, P.E.
Senior Geotechnical Engineer

Penobscot County
WIN 16682.00

Soils Report No. 2011-29
Bridge No. 5790

Fed No. IM-1668(200)E
November 23, 2011

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Tables

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Sheets

Appendices

GEOTECHNICAL DESIGN SUMMARY

This report provides geotechnical recommendations for replacement of the Ohio Street Bridge over Interstate 95 in Bangor, Maine. The replacement structure will be a two-span semi-integral bridge with cantilever-type abutments on spread footings cast on compacted fill or native glacial till. The abutments will include U-shaped return wingwalls and cast-in-place protected slopes in front of the breastwalls. The replacement bridge design will conform to the requirements of the Bridge Design Guide (BDG) and the AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010, (herein referred to as LRFD). The design and construction recommendations below are discussed in greater detail in Section 7.0 Geotechnical Design Recommendations.

Cantilever Abutments and Wingwalls– The abutments and wingwalls will be designed to resist all lateral earth loads, vehicular loads, superstructure loads, traffic impact and any loads transferred through the superstructure as appropriate. Abutments and wingwalls will be designed for all relevant service, strength and extreme limit states in accordance with LRFD.

The design of project abutments founded on spread footings at the strength and extreme limit states shall consider nominal bearing resistance, eccentricity (overturning), lateral sliding and structural failure. A sliding resistance factor, φ_τ, of 0.80 shall be applied to the nominal sliding resistance of abutments and wingwalls founded on spread footings on soil. A maximum frictional coefficient of 0.55 at the soil-concrete interface should be assumed. For footings on soil, the eccentricity of loading at the strength limit state, based on factored loads, shall not exceed one-quarter (1/4) of the footing dimensions, in either direction.

Service limit load conditions may control substructure foundation design of the Ohio Street Bridge. A resistance factor of 1.0 shall be used to assess spread footing design at the service limit state, including: settlement, excessive horizontal movement and overall stability. The overall global stability of a foundation is typically investigated during final design by the geotechnical engineer at the Service I Load Combination and a resistance factor, φ, of 0.65. The foundations shall be constructed a minimum of 6.5 feet below exterior finished grade.

Earth loads shall be calculated using an active earth pressure coefficient, K_a, of 0.31 calculated using Rankine Theory for cantilever wingwalls. The designer may assume Soil Type 4 [Bridge Design Guide (BDG) Section 3.6.1] for backfill soil properties. The backfill properties are as follows: ϕ = 32 degrees, γ = 125 pounds per cubic foot (pcf). Additional lateral earth pressure due to construction or live load surcharge is required for the abutments and wingwalls if an approach slab is not specified. If a structural approach slab is specified, some reduction of surcharge loads is permitted.

All abutment and wingwall designs shall include a drainage system behind them to intercept any groundwater. Drainage behind the structure shall be in accordance with Section 5.4.1.4, Drainage, of the BDG. The footing subgrade excavation should be protected from disturbance by construction traffic or water-softening. We recommend that the contractor place and compact a 12-inch thick layer of granular borrow over the excavated subgrade to prepare the site for foundation construction and protect the native subgrade soil from disturbance.

The abutment and wingwall footing elevations must be determined in the final design phase. Although preliminary foundation elevations are presented in the Ohio Street Bridge Preliminary Design Report (PDR), site conditions, construction staging, utilities or other final design considerations may require establishment of footing elevations different than proposed in the preliminary design concept.

If wingwalls are designed with step-up foundations constructed over pre-existing fill soil, the fill soil shall be sampled and subjected to Proctor tests. The wingwall footing subgrade soil shall then be compacted to 95% of the maximum dry density in accordance with AASHTO T-180.

Pier Foundation – Strength and extreme limit state design of the pier foundation shall consider bearing resistance, eccentricity (overturning), failure by sliding and structural failure. Extreme event load combinations are those relating to vehicle collision.

Service limit load conditions may control foundation design of the Ohio Street Bridge. Service limit state design checks shall be used to assess pier footing settlement, horizontal movement, bearing resistance, sliding and eccentricity. The overall global stability of a foundation is typically investigated during final design by the geotechnical engineer at the Service I Load Combination and a resistance factor, φ, of 0.65. The foundation shall be constructed a minimum of 6.5 feet below exterior finished grade.

For sliding analyses at the strength limit state, a sliding resistance factor of φ_τ, of 0.80 shall be applied to the nominal sliding resistance of abutments and wingwalls founded on spread footings on soil. A maximum frictional coefficient of 0.55 at the soil-concrete interface should be assumed. For pier footings on soil, the eccentricity of loading at the strength limit state based on factored loads shall not exceed one-quarter (1/4) of the footing dimensions, in either direction.

The pier footing elevation must be determined in the final design phase. Although a preliminary foundation elevation is presented in the Ohio Street Bridge PDR, site conditions, construction staging, utilities or other final design considerations may require establishment of a footing elevation different than proposed in the preliminary design concept.

Vehicle Collision Extreme Event Design - Any abutment, pier or wingwall constructed within 30 feet of the edge of the roadway must be protected from vehicular collision with barriers as specified in LRFD Article 3.6.5.1. If barriers are not used, the abutment, pier or wingwall shall be designed for an equivalent static force of 400 kips assumed to act in any direction in a horizontal plane at a distance of 4.0 feet above the ground surface. The Extreme Event II limit state design check related to collision by vehicles includes bearing resistance, eccentricity, sliding and structural failure. A resistance factor $\varphi = 1.0$ is used for the Extreme Event II limit state. Current design concepts include a concrete revetment in front of the abutments but the current pier design concept must consider extreme event conditions.

Factored Bearing Resistance – Based on presumptive bearing resistance values and local experience, a factored bearing resistance of 4 ksf should be used when analyzing the service limit state and for footing sizing to control settlement, as allowed in LRFD C10.6.2.6.1. The strength and extreme limit state factored bearing resistances for spread footings on compacted granular fill or native glacial till shall depend on the footing size as presented in the graph in Section 7.4 of this report. In no instance shall the service limit state bearing stress exceed the nominal resistance of the footing concrete, which may be taken as $0.3f'c$. The minimum footing size is 2 feet wide regardless of the applied bearing pressure or bearing material.

Settlement – We estimate that settlement as a result of fill replacement and minor embankment fill extensions over natural soils will be negligible. We have estimated that the total settlement of a prepared subgrade consisting of compacted fill or native glacial till will be on the order of 1 inch for conventional spread footings where service limit state loads are no greater than 4 ksf. We estimate that differential settlement will be on the order of ½-inch or less. In all cases above, this settlement is acceptable and will occur during construction. We anticipate that post-construction settlement will be negligible.

Frost Protection – Foundations placed on granular soils shall be founded a minimum of 6.5 feet below finish exterior grade for frost protection. This minimum embedment depth applies only to foundations placed on soil and not those founded on bedrock.

Seismic Design Considerations – Seismic analysis is not required for multiple-span bridges in Seismic Zone 1. Nevertheless, superstructure connections and bridge seat dimensions shall be designed in accordance with LRFD requirements. The following are the Ohio Street Bridge seismic design parameters:

- Peak Ground Acceleration coefficient (PGA) = 0.067g
- Design spectral acceleration coefficient at 0.2-second period, S_{DS} = 0.175g
- Design spectral acceleration coefficient at 1.0-second period, S_{D1} = 0.075g
- Site Class C (very dense soil with $N_{avg} > 50$ blows per foot)
- Seismic Zone 1, based on an $S_{D1} < 0.15g$

Construction Considerations –

Excavation

- Remove the old abutments and pier in their entirety. This will require staged construction methods and earth support systems.
- Construction of new abutment, pier and retaining wall structures will require soil excavation. Earth support systems may be required at the abutments and will be required at the pier.

Subgrade Preparation

- The high fines and water contents of the native glacial till make this soil susceptible to disturbance and rutting as a result of exposure to water or construction traffic. If disturbance and/or rutting occur, the contractor should remove and replace the disturbed soil materials and replace it with compacted granular borrow.
- If any of the abutment or wing wall footings will be designed to bear on existing fill soils, over-excavate the footing location 2 feet and replace the excavated soil with

granular borrow. Prior to placing the granular borrow, subject the fill subgrade soil to Proctor testing and then compact the fill subgrade to 95% of the maximum dry density as determined by AASHTO T-180. The contractor should subsequently place granular borrow up to the proposed new subgrade level and compact it to 95% of the AASHTO T-180 maximum dry density prior to constructing the footings.

Dewatering

- Control groundwater and surface water infiltration to permit construction in-the-dry.
- Cofferdams, temporary ditches, pumping from sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment may be needed to divert surface water or groundwater if significant seepage is encountered during excavation.

Reuse of Excavated Soil and Bedrock

- Do not use excavated existing subbase aggregate for pavement structure construction or to re-base shoulders or for abutment and wall backfill soil. Excavated subbase sand and gravel may be used as fill below subgrade elevation in fill embankment areas.
- Do not use excavated existing fill or native soils for fill anywhere beneath the pavement structure, dressing slopes, abutments or walls. Use these soils to dress slopes only below the bottom elevation of the shoulder subbase gravel.
- Silty native soils or existing fill soils may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. It may be necessary to spread out and dry portions of these soils that are excessively moist.

Embankment Fill Areas

- Bench existing fill slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, where new fill slope extensions are constructed over existing slopes.

Erosion Control

- Use MaineDOT Best Management Practices February 2008 to minimize erosion of fine-grained soils found on the project site.

1.0 INTRODUCTION

The Maine Department of Transportation (MaineDOT) plans to replace the Ohio Street Bridge over Interstate 95 in the Town of Bangor, Penobscot County, Maine. We show the project location on Sheet 1, Location Map found at the end of this report. We conducted subsurface investigations at the bridge site to develop geotechnical recommendations for the structure replacement. This report summarizes our findings, discusses our evaluation of the subsurface conditions and presents our geotechnical recommendations for design and construction of the bridge foundations.

The existing simply supported two-span steel I-beam bridge was originally built in 1960. The abutments were founded on spread footings formed and cast over native glacial till soil. The existing bridge was last rehabilitated in 1987 where the scope of work included: a new strip seal at the expansion joint, 4 new railing end posts, 2 new deck drains, a new 3-inch bituminous concrete wearing surface with waterproofing membrane. Also, the steel girders are currently in good condition and were repainted circa 1989.

MaineDOT is considering bridge replacement due to deck cracking, under-deck concrete spalling with some delamination and efflorescence and corrosion of exposed rebar, pier and abutment cracks. Many of the bridges along the I-95 corridor in Bangor were constructed around the same time and a number of these bridges have shown signs of Alkali-Silica-Reactivity (ASR). The Ohio Street Bridge also does not provide adequate under-clearance. The bridge had a sufficiency rating of 82.6 in 2010. Considering the sufficiency rating and current economic challenges, MaineDOT Bridge Program management has decided to defer replacement of the bridge until at least 2016. Nevertheless, preliminary studies and design work have been undertaken in anticipation of future bridge replacement.

Preliminary design studies by Becker Structural Engineers, Inc. of Portland, Maine, have identified cantilever-type abutments on spread footings to be the most practicable foundation type for this site. The spread footings will be founded directly on compacted fill or native glacial till soil. The proposed bridge will consist of a 180-foot, two-span steel girder superstructure with a total width of 60 feet. The bridge will have a curb-to-curb width of 45 feet which will accommodate two 12-foot travel lanes, one 11-foot turning lane with two 5-foot wide shoulders. The proposed bridge also includes two 6-foot wide sidewalks. The current bridge replacement plans include profile changes of approximately 2 feet higher than original grades mostly over the eastern span and grading back down to original grade roughly 150 feet west of and 200 feet east of the bridge.

2.0 GEOLOGIC SETTING

The Ohio Street Bridge foundations and approaches are constructed onto the backslopes and base of a large open cut in the native glaciated sediments. The highway cut was excavated for the construction of twin northbound and southbound lanes for Interstate 95.

The Maine Geologic Survey (MGS) "Surficial Geology of Bangor Quadrangle, Maine, Open-file No. 77-24" (1977) indicates that surficial soils in the vicinity of the Ohio Street Bridge are predominantly glacial till deposits with nearby glacial-marine soil unit and bedrock outcrop unit contacts. The glacial till is typically a heterogeneous mixture of sand, silt, clay, and stones. Glacial-marine deposits generally consist of silt, clay, and sand, commonly a clayey silt, but sand is abundant at the surface in some places.

According to the Maine Geologic Survey "Bedrock Geologic Map of Maine" (1985), the bedrock at the Ohio Street Bridge site consists of Silurian-Ordovician, calcareous sandstone, interbedded sandstone and impure limestone. Locally the bedrock has been identified as phyllite, metasiltstone and metasandstone and is part of the Vassalboro Formation.

3.0 SUBSURFACE INVESTIGATION

We investigated subsurface conditions in the vicinity of the existing bridge by drilling six test borings, BB-BOHS-101 through BB-BOHS-106. The approximate boring locations are shown on Sheet 2, Boring Location Plan, found at the end of this report. We terminated all of the borings with bedrock cores. The MaineDOT drill rig and crew and the contract drill crew, Northern Test Borings of Gorham, Maine, conducted the borings on May 12 through May 20, 2009. We present the details and sampling methods used, field data obtained, and soil and groundwater conditions encountered in the boring logs in Appendix A provided at the end of this report.

The MaineDOT geotechnical team member selected the boring locations and drilling methods, designated the type and depth of sampling techniques, and identified field and laboratory testing requirements. A geotechnical engineer or a MaineDOT New England Transportation Technician Certification Program (NETTCP) Certified Subsurface Inspector logged the subsurface conditions in the borings. The MaineDOT survey crew determined the boring location coordinates in the field after the borings were completed. The survey elevations are based on the NAVD 88 datum.

The borings were drilled using solid stem auger and cased wash boring techniques. Soil samples were obtained, where possible, at 5-foot intervals using Standard Penetration Test (SPT) methods. The standard penetration resistances, or N-values, discussed in this report are corrected for average hammer energy transfer. We compute the SPT N_{60}-values by applying an average hammer energy transfer factor to the raw field N-values we obtain. We used average hammer energy transfer factors of 0.678, 0.76 and 0.84 for the Northern Test Boring trailer rig, Northern Test Boring ATV rig, and the MaineDOT drill rig, respectively. Bedrock was cored using an NQ-2 core barrel producing a 2.0-inch diameter rock core.

4.0 LABORATORY TESTING PROGRAM

We conducted a laboratory soil testing program on selected samples recovered from the test borings to evaluate soil classification and soil properties. We performed the soil laboratory testing at the AASHTO accredited MaineDOT Soils Laboratory in Bangor, Maine. Laboratory testing consisted of 17 standard grain size analyses with natural water content.

We present the results of the laboratory testing in Appendix B, Laboratory Test Data. The AASHTO and Unified Soil Classification System (USCS) soil classification and water content data are also presented on the boring logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

Regional surficial geology maps show that the bridge site is situated in an area where glacial till deposits predominate with nearby glacial-marine soil unit and bedrock outcrop unit contacts. The bridge itself is situated at the end of short fill extensions built into the I-95 highway cut. The approach embankment soil behind existing bridge abutment No. 1 is granular fill overlying approximately 4.5 feet of glaciomarine silty sand or silt over 12.9 to 21.4 feet of glacial till in BB-BOHS-103 and BB-BOHS-104, respectively. Behind existing bridge abutment No. 2, we encountered granular fill overlying approximately 20.8 to 24.7 feet of glacial till in BB-BOHS-101 and BB-BOHS-106, respectively. Each of the abutment borings also encountered and penetrated concrete approach slabs within the granular fill layer.

At the pier location, we observed granular fill over approximately 11.2 to 12.4 feet of glacial till. The glacial till overlies bedrock at all the abutment and pier boring locations. A summary description of the subsurface conditions follows.

5.1 Granular Fill

We encountered granular fill to a depth ranging between approximately 3.5 and 9.5 feet below ground surface (bgs) at the abutment locations. At the pier locations we observed approximately 4.0 to 5.8 feet of granular fill. The granular fill consists of fine to coarse sand, with some gravel to gravelly and trace to little silt. The SPT N_{60}-values in the granular fill ranged from 30 to 75 blows per foot (bpf) indicating that the unit is medium dense to very dense in consistency.

The granular fill samples selected for laboratory testing had water contents ranging between approximately 3 and 5 percent. Grain size analyses conducted on selected samples of the fill soils indicate that the soils are classified as A-1-a and A-1-b by the AASHTO Classification System and SM under the Unified Soil Classification System.

5.2 Glaciomarine Silty Sand and Silt

We encountered glaciomarine silty sand and silt beneath the approach fills in abutment borings BB-BOHS-103 and BB-BOHS-104. This soil unit consists of silty fine sand with trace medium sand, or silt with some fine to medium sand and trace gravel. The thickness of the glaciomarine sediments we encountered were approximately 4.5 feet. SPT N_{60}-values were 8 bpf for both the silty sand and silt soil units, indicating those deposits are loose or medium stiff in consistency, respectively. The silty sand had a natural water content of approximately 18 percent and grain size analysis indicated that the soil is classified as A-4 and SM by the AASHTO and Unified Soil Classification Systems, respectively. The glaciomarine silt had a natural water content of approximately 28 percent and grain size analysis indicates that the soil is classified as A-4 and ML by the AASHTO and Unified Soil Classification Systems, respectively. Below the glaciomarine silty sand and silt we encountered the glacial till soil unit.

5.3 Glacial Till

The glacial till found in the borings generally comprised of silt with trace to some fine to coarse sand and trace to some gravel, or gravelly fine to coarse sand with some silt, or fine to coarse sandy silt with little to some gravel, typically with occasional to numerous cobbles. The glacial till unit was often well bonded or cemented also. The thickness of this soil unit ranged between approximately 12.9 to 24.7 feet at the abutment locations and approximately 11.2 to 12.4 feet at the pier locations. SPT N_{60}-values ranged from 8 to 46 bpf, indicating the till deposit is loose to dense in consistency. We observed the glacial till unit over bedrock in each of the borings.

The glacial till samples had water contents ranging between approximately 9 and 20 percent. Grain size analyses conducted on selected samples of the till soils indicate that the soils are classified as A-4 by the AASHTO Classification System and ML or SM under the Unified Soil Classification System.

5.4 Bedrock

We encountered bedrock at approximate depths ranging from 21.9 to 34.2 feet bgs at the abutment locations and 16.4 to 17.0 feet bgs at the pier locations. Regionally, the bedrock is mapped by MGS as calcareous sandstone, interbedded sandstone and impure limestone of the Vassalboro Formation. We visually identified the local bedrock cores at all the boring locations as a grey, fine-grained, metasedimentary phyllite, metasiltstone and metasandstone that is soft to moderately hard, slightly to moderately weathered with very close to close open joints. The bedrock contains fractures that are oriented from horizontal to vertical and have minor silt in-filling and iron-staining. The bedrock also contains numerous quartz and calcite seams 2 to 4 mm thick. We determined that the rock quality designation (RQD) of the bedrock ranged from 0 to 28 percent which correlates to a very poor to poor rock mass quality. Table 5-1 below summarizes the top of bedrock elevations at the boring locations:

Substructure	Boring	Station	Depth to Bedrock (feet bgs)	Elev. of Apparent Bedrock Surface (feet)
Abutment No. 1	BB-BOHS-103	25+91.9, 15.1 LT	21.9	109.2
Abutment No. 1	BB-BOHS-104	25+91.9, 20.1 RT	29.4	101.6
Abutment No. 2	BB-BOHS-101	28+08.6, 14.9 LT	28.8	104.3
Abutment No. 2	BB-BOHS-106	28+05.3, 21.8 RT	34.2	98.8
Pier	BB-BOHS-102	26+92.9, 36.8 LT	17.0	93.4
Pier	BB-BOHS-105	26+87.3, 36.5 RT	16.4	96.2

Table 5-1. Bedrock Depth and Elevation at the Boring Locations

5.5 Groundwater

We observed the groundwater level at an approximate depth of 6.5 feet bgs in boring BB-BOHS-105 and none was observed in any of the other borings. However, the groundwater level will fluctuate with seasonal changes, runoff, and adjacent construction activities.

For a more detailed description of the subsurface conditions, please refer to Appendix A, Boring Logs attached to this report.

6.0 FOUNDATION ALTERNATIVES

Both rehabilitation and replacement options were initially considered. The rehabilitation options were dismissed because they would not correct the inadequate bridge under-clearance condition. In a companion Union Street Bridge project approximately 1500 feet south of the Ohio Street Bridge, a number of replacement options were considered and the resulting conclusion was also applied to the Ohio Street Bridge project. Replacement options considered for the Union Street Bridge included mechanically stabilized earth MSE supported semi-integral stub abutments, integral abutments, and conventional spread footing substructures, and butted box beam or welded steel girder superstructures.

MSE supported abutments were eliminated because of the surface area required to accommodate the minimum 22-foot long reinforcing strips. Integral abutments were dismissed because this site requires long U-shaped wingwalls contrary to the 10-foot maximum length straight extension wingwalls allowed for integral abutments per BDG Section 5.4.2.9. The butted box beams were eliminated because of difficulties accommodating existing utility ducts, inability to follow the planned bridge vertical curve, and expense. Consequently, the most practical and durable alternative is a welded steel girder superstructure supported on full height cantilever abutments on conventional spread footings. Section 7.0, Geotechnical Design Recommendations, of this report provides recommendations for the full height cantilever abutments, the pier and retaining walls on spread footings founded on compacted fill or native glacial till.

7.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

The preliminary bridge alternate selected for the Ohio Street Bridge replacement is a two-span welded steel girder superstructure supported by full height cast-in-place cantilever abutments and wingwalls on spread footings cast directly on compacted fill or native glacial till. The new pier will also be founded on a spread footing cast directly on compacted fill or native glacial till. The new bridge has a proposed total width of 60 feet and length of 180 feet. The design methodology used in the following evaluation is referenced from the AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010.

7.1 Abutment and Wingwall Design

Abutments and wingwalls shall be proportioned for all applicable load combinations in LRFD Articles 3.4.1 and 11.5.5 and shall be designed for all relevant strength, service and extreme limit states. The design of project abutments and wingwalls founded on spread footings at the strength limit state shall consider nominal bearing resistance, eccentricity (overturning), lateral sliding and structural failure.

A sliding resistance factor, φ_τ, of 0.80 shall be applied to the nominal sliding resistance of cast-in-place abutments and wingwalls founded on spread footings on compacted fill or glacial till. Sliding computations for resistance to lateral loads shall assume a maximum frictional coefficient of 0.55 at the concrete footing to soil interface. For footings on soil, the eccentricity of loading at the strength limit state, based on factored loads, shall not exceed one-quarter (1/4) of the footing dimensions, in either direction.

Service limit load conditions may control foundation design of the Ohio Street Bridge. A resistance factor of 1.0 shall be used to assess spread footing design at the service limit state, including: settlement, excessive horizontal movement and overall stability. The overall global stability of a foundation is typically investigated during final design by the project geotechnical engineer using the Service I Load Combination and a resistance factor, φ, of 0.65. The foundations shall be constructed a minimum of 6.5 feet below exterior finished grade.

Cantilever-type abutments and wingwalls shall be designed as unrestrained meaning that they are free to rotate at the top in an active state of earth pressure. Earth loads shall be calculated using an active earth pressure coefficient, $K_a = 0.31$, calculated using Rankine Theory for cantilever-type abutments and wingwalls. See Appendix C – Calculations, for supporting documentation. The designer may assume Soil Type 4 (BDG Section 3.6.1) for backfill material soil properties. The backfill properties are as follows: $\phi = 32$ degrees, $\gamma = 125$ pcf.

Additional lateral earth pressure due to construction surcharge or live load surcharge is required per Section 3.6.8 of the BDG for the abutments and wingwalls if an approach slab is not specified. In the case where a structural approach slab is specified, reduction of the surcharge loads is permitted per LRFD Article 3.11.6.5. The live load surcharge on walls may be estimated as a uniform horizontal earth pressure due to an equivalent height of soil (h_{eq}) of no less than 2.0 feet, per LRFD Table 3.11.6.4-1. The live load surcharge on abutments may be estimated as a uniform earth pressure due to an equivalent height of soil (h_{eq}) taken from the Table 7-1 below:

Abutment Height (feet)	h_{eq} (feet)
5.0	4.0
10.0	3.0
$\geq$ 20.0	2.0

Table 7-1. Equivalent Height of Soil for Estimating Live Load Surcharge

All abutment and wingwall designs shall include a drainage system behind them to intercept any groundwater. Drainage behind the structure shall be in accordance with BDG Section 5.4.1.4, Drainage. The footing subgrade excavation should be protected from disturbance by construction traffic or water-softening. We recommend that the contractor place and compact a 12-inch thick layer of granular borrow over the excavated subgrade to prepare the site for foundation construction and protect the native subgrade soil from disturbance.

Backfill within 10 feet of the abutments and wingwalls and side slope fill shall conform to MaineDOT Specification 709.19, Granular Borrow for Underwater Backfill. This gradation specifies 10 percent or less of material passing the No. 200 sieve. This material is specified in order to reduce the amount of fines and to minimize frost action behind the structure and below the approach slab.

If wingwalls are designed with step-up foundations constructed over pre-existing fill soil, the fill soil shall be sampled and subjected to Proctor tests. The wingwall footing subgrade soil shall then be compacted to 95% of the maximum dry density in accordance with AASHTO T-180.

Abutment and wingwall design shall also consider extreme event load combinations relating to vehicle collision, including bearing resistance, eccentricity (overturning), failure by sliding and structural failure as discussed in Section 7.3, Vehicle Collision Extreme Event Design.

The abutment and wingwall footing elevations will be determined in the final design phase. Although preliminary foundation elevations are presented in the Ohio Street Bridge PDR, site conditions, construction staging, utilities or other final design considerations may require establishment of footing elevations different than proposed in the preliminary design concept.

7.2 Pier Foundation Design

The pier foundation shall be proportioned for all applicable load combinations specified in LRFD Articles 3.4.1 and 11.5.5 and shall be designed for all relevant strength, extreme and service limit states. The pier foundation strength limit state design shall consider bearing resistance, eccentricity (overturning), failure by sliding and structural failure. For sliding analyses at the strength limit state, a sliding resistance factor of φ_τ, of 0.80 shall be applied to the nominal sliding resistance of a pier founded on a spread footing on soil. A maximum frictional coefficient of 0.55 at the soil-concrete interface should be assumed. For pier footings on soil, the eccentricity of loading at the strength limit state based on factored loads shall not exceed one-quarter (1/4) of the footing dimensions, in either direction.

Service limit state load conditions may control foundation design at the Bangor Ohio Street site. A resistance factor, φ, of 1.0 shall be used to assess pier footing settlement, horizontal movement, bearing resistance, sliding and eccentricity. The overall global stability of a foundation is typically investigated by the project geotechnical engineer during final design using the Service I Load Combination and a resistance factor, φ, of 0.65. The foundations shall be constructed a minimum of 6.5 feet below exterior finished grade.

The pier design shall also consider the extreme event load combination relating to vehicle collision, including bearing resistance, eccentricity (overturning), failure by sliding and structural failure as discussed in Section 7.3, Vehicle Collision Extreme Event Design.

The pier footing elevation must be determined in the final design phase. Although a preliminary foundation elevation is presented in the Ohio Street Bridge PDR, site conditions, construction staging, utilities or other final design considerations may require establishment of a footing elevation different than proposed in the preliminary design concept.

7.3 Vehicle Collision Extreme Event Design

Any abutment, pier or wingwall constructed within 30 feet of the edge of the roadway must be protected from vehicular collision with barriers as specified in LRFD Article 3.6.5.1. If barriers are not used, the abutment, pier or wingwall shall be designed for an equivalent static force of 400 kips assumed to act in any direction in a horizontal plane at a distance of 4.0 feet above the ground surface. The Extreme Event II limit state design check related to collision by vehicles includes bearing resistance, eccentricity, sliding and structural failure. A resistance factor $\varphi = 1.0$ is used for the Extreme Event II limit state as specified in LRFD Article 11.5.7. The extreme event factored bearing resistances are presented in Section 7.4, Factored Soil Bearing Resistance.

7.4 Factored Soil Bearing Resistance

Substructure spread footings shall be proportioned to provide stability against bearing capacity failure. Application of permanent and transient loads are specified in LRFD Article 11.5.5. The stress distribution may be assumed to be a triangular or trapezoidal distribution over the effective base as shown in LRFD Figure 11.6.3.2-2. The factored bearing resistance for any structure founded on compacted fill or native glacial till shall be investigated at the strength and service limit states using factored loads and a factored bearing resistance dependent on the proposed footing width.

Figure 7-1 below shows the appropriate factored bearing resistance for comparable effective footing widths, B' for the strength limit state. These bearing resistances assume a bearing resistance factor, φ_b, for spread footings on soil of 0.45, based on bearing resistance evaluation using semi-empirical methods.

A service limit factored bearing resistance of 4 ksf as shown on Figure 7-1 below may be used for preliminary footing sizing and to control settlements when analyzing the service limit state load combination. These bearing resistances assume a bearing resistance factor, φ, of 1.0. The service limit state loading conditions may control foundation design for the Ohio Street Bridge project. See Appendix C, Calculations, for supporting documentation.

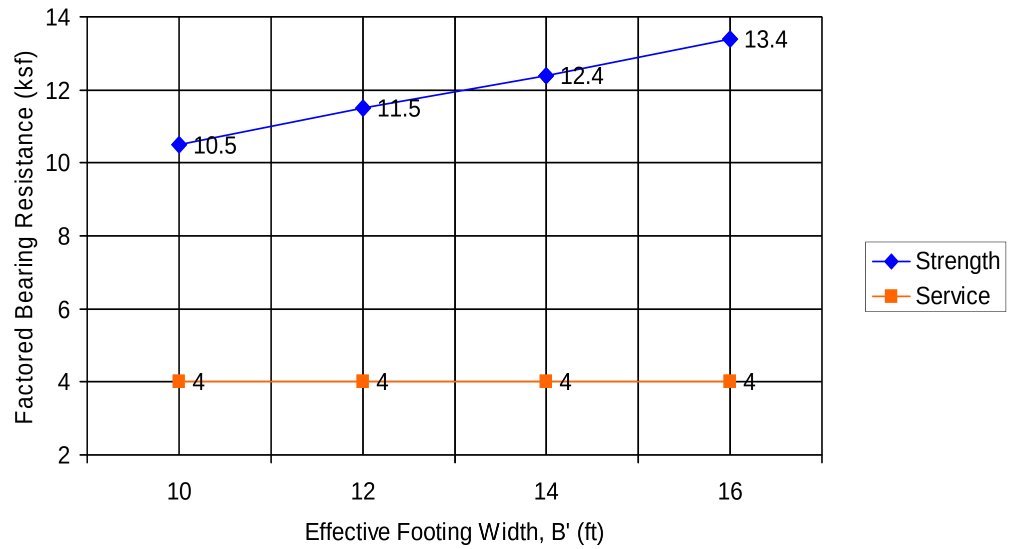

Figure 7-1. **Strength and Service Limit State Factored Bearing Resistance for Spread Footings on Glacial Till or Compacted Fill**

The extreme limit state factored bearing resistances are dependent on footing size. Figure 7-2 below shows the appropriate bearing resistance for comparable effective footing widths, B'. These extreme event bearing resistances assume a factor, φ, of 1.0 for spread footings on soil as required by LRFD 11.5.7.

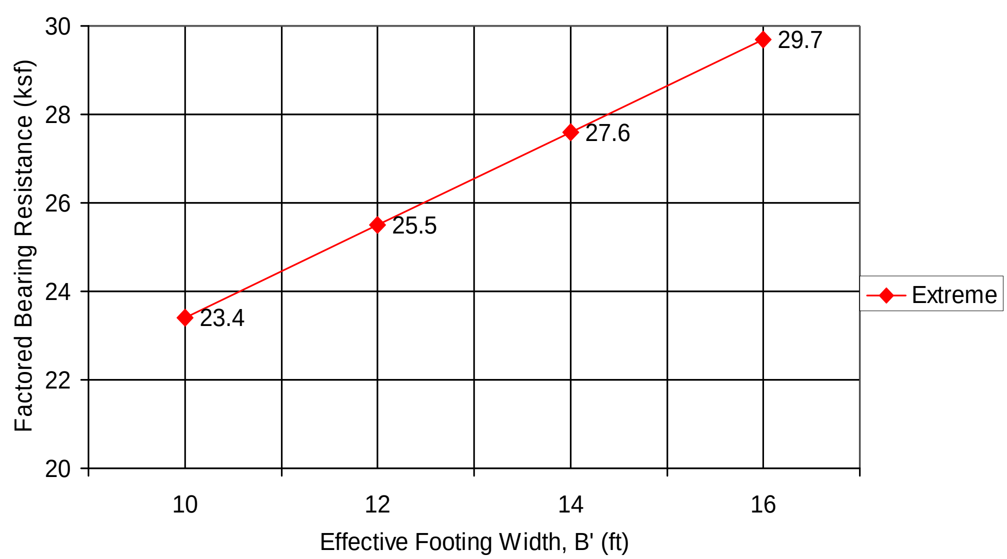

Figure 7-2. **Extreme Limit State Factored Bearing Resistance for Spread Footings on Glacial Till or Compacted Fill**

In no instance shall the factored strength, service or extreme limit state bearing stress exceed the nominal compressive resistance of the footing concrete, which may be taken as $0.3f'c$. No footing shall be less than 2 feet wide regardless of the applied bearing pressure or bearing material.

7.5 Settlement

We estimate that settlement as a result of fill replacement and minor embankment fill extensions over natural soils will be negligible. We have estimated that the total settlement of a prepared subgrade consisting of compacted fill or native glacial till will be on the order of 1 inch for conventional spreads footings where service limit state loads are no greater than 4 ksf. Supporting Calculations are provided in Appendix C. We estimate that differential settlement will be on the order of ½-inch or less. In all cases above, this settlement is acceptable and will occur during construction. We anticipate that post-construction settlement will be negligible.

7.6 Frost Protection

We have evaluated the potential frost depth at the site for footings placed on soil. Based on State of Maine frost depth maps, BDG Figure 5-1, the site has a design-freezing index of approximately 1730 F-degree days. Considering an assumed water content of 10 percent, this correlates to a frost depth of 7.4 feet at this site. We also considered frost depth projections computed by Modberg software developed by the US Army Cold Regions Research and Engineering Laboratory. The results of the Modberg frost depth model indicate a potential frost depth of 6.5 feet. Consequently, we recommend that any foundations or leveling pads constructed on soil at this site be founded a minimum of 6.5 feet below finished exterior grade. This minimum embedment applies only to foundations constructed on soil and not those founded on bedrock.

7.7 Seismic Design Considerations

The replacement Ohio Street Bridge in Bangor will be a multiple span bridge over Interstate 95 which is on the National Highway System. The bridge may be considered "essential" or "critical" according to the operational classifications of LRFD Article 3.10.5. LRFD Article 4.7.4.1 specifies that seismic analysis is not required for essential or critical multi-span bridges in Seismic Zone 1. However, superstructure connections, bridge seat dimensions and support lengths at expansion bearings should all be designed per LRFD Articles 3.10.9 and 4.7.4.4.

The following parameters were determined for the site from the USGS Seismic Parameters CD provided with the LRFD Manual and LRFD Articles 3.10.3.1 and 3.10.6:

- Peak Ground Acceleration coefficient (PGA) = 0.067g
- Design spectral acceleration coefficient at 0.2-second period, $S_{DS} = 0.175g$
- Design spectral acceleration coefficient at 1.0-second period, $S_{D1} = 0.075g$
- Site Class C (very dense soil with $N_{avg} > 50$ blows per foot)
- Seismic Zone 1, based on an $S_{D1} < 0.15g$

7.8 Construction Considerations

7.8.1 Excavation

We anticipate that the existing abutments and pier will be removed in their entirety using staged construction methods. Earth support systems, shoring or braced excavations may be needed.

Construction of the new abutment structures, new pier and new retaining walls will require soil excavation. Earth support systems may be required at the abutment locations. The pier foundation excavation will require an internally braced earth support structure.

Surface water should be diverted from the foundation excavations throughout the period of construction. We recommend removing any groundwater encountered at the base of the foundation excavations by using a sump pump located in a corner of the excavation outside of the foundation footprint.

7.8.2 Subgrade Preparation

The silty native soils at the site are susceptible to water softening, rutting and/or disturbance as a result of exposure to water or construction activity. The contractor must protect the subgrade from exposure to water and any unnecessary construction traffic. If disturbance and/or rutting occur, we recommend that the contractor remove the disturbed soil materials and replace it with compacted granular borrow.

If any of the abutment or wingwall footings will be designed to bear on existing fill soils, over-excavate the footing location 2 feet and replace the excavated soil with granular borrow. Prior to placing the granular borrow, we recommend that the contractor subject the fill subgrade soil to Proctor testing and then compact the fill subgrade to 95% of the maximum dry density as determined by AASHTO T-180. The contractor should subsequently place granular borrow up to the proposed new subgrade level and compact it to 95% of the AASHTO T-180 maximum dry density prior to constructing the footings.

7.8.3 Dewatering

Water seepage may occur during construction and the silty native silty soils at the site may become saturated potentially resulting in localized sloughing and instability in some excavations and cut slopes. The contractor should control groundwater and surface water infiltration to permit construction in-the-dry. We recommend that the contractor use temporary ditches, sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment to divert surface water and groundwater if significant seepage is encountered during construction. We also recommend using French drains daylighted to nearby ditches if significant seepage is encountered in the subgrade along the construction areas.

7.8.4 Reuse of Excavated Soil and Bedrock

The project plans call for excavation of the existing approach areas to achieve planned grades. In the process, the contractor will excavate both the existing subbase gravel, and subgrade fill soils. We do not recommend using the excavated subbase aggregate to re-base the bridge approaches. Excavated subbase and any granular fill excavation may be used as fill below subgrade elevation in fill embankment areas provided all other requirements of MaineDOT Standard Specification Sections 203 and 703 are met.

We do not recommend using excavated native soils as fill directly beneath the pavement structure. The silty native soils are typically susceptible to strength loss when wet or disturbed. The excavated soils may be allowed as fill in accordance with the Standard Specification 203 as shown on Standard Detail 203 (01). This soil may also be used for dressing slopes, but only below the bottom elevation of the shoulder subbase gravel.

The native silty soils or existing fill soils may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. Contractors should expect that prior to placement and compaction it may be necessary to spread out and dry portions of these soils that are excessively moist.

7.8.5 Embankment Areas Outside of Abutment/Wingwall Backfill Envelope

Embankment approach slopes that are created or extended as part of the bridge construction effort should be designed as earth fill slopes no steeper than 2:1 (H:V). Slopes steeper than 2:1 (H:V) typically require reinforcement, rock fill surfacing or retaining walls.

We recommend that all new embankment fill be thoroughly and systematically compacted to the full limit of the slope. Where new fill slope extensions are constructed over existing slopes, we recommend benching the existing slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, to prevent creation of a preferential slip plane under the new embankment fill.

7.8.6 Erosion Control Recommendations

The fine-grained soils along the project are susceptible to erosion. We recommend using appropriate erosion control measures during construction as described in the MaineDOT Best Management Practices February 2008 guidelines to minimize erosion of the fine-grained soils at the site.

8.0 CLOSURE

This report has been prepared for use by the MaineDOT Bridge Program for specific application to the replacement of the Ohio Street Bridge over Interstate 95 in Bangor, Maine. We have prepared the report in accordance with generally accepted soil and foundation engineering practices. No other intended use or warranty is expressed or implied.

In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes in design. Further, the analyses and recommendations are based in part upon limited soil explorations completed at discrete locations on the project site. If variations from the conditions encountered during the investigation appear evident during construction, it may also become necessary to re-evaluate the recommendations made in this report.

We recommend that we be provided the opportunity for a general review of the final design drawings and specifications in order that we may verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the design.

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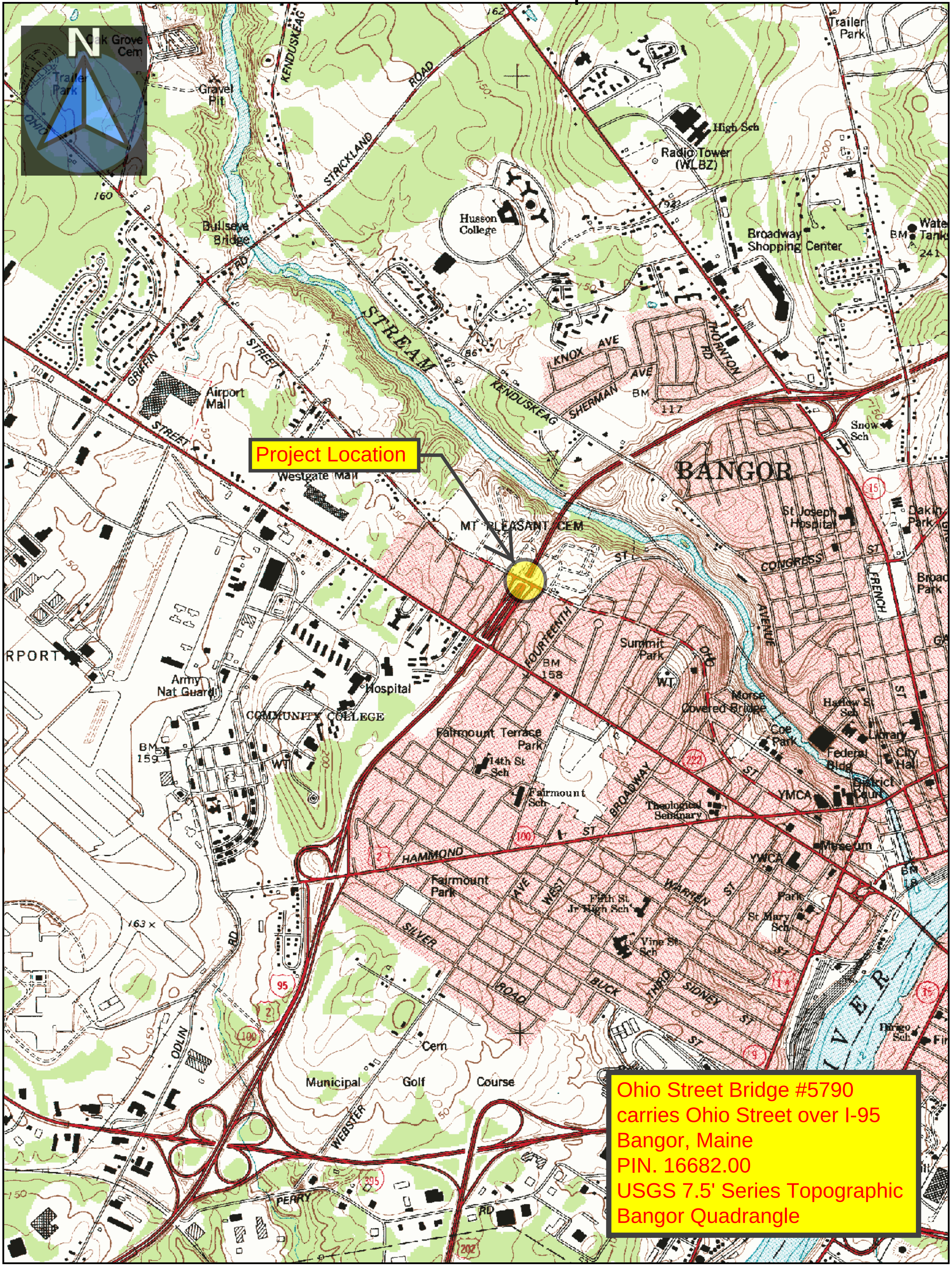
Sheets

Location Map

Sheet 1



Map Scale 1:24000

The Maine Department of Transportation provides this publication for information only. Reliance upon this information is at user risk. It is subject to revision and may be incomplete depending upon changing conditions. The Department assumes no liability if injuries or damages result from this information. This map is not intended to support emergency dispatch. Road names used on this map may not match official road names.

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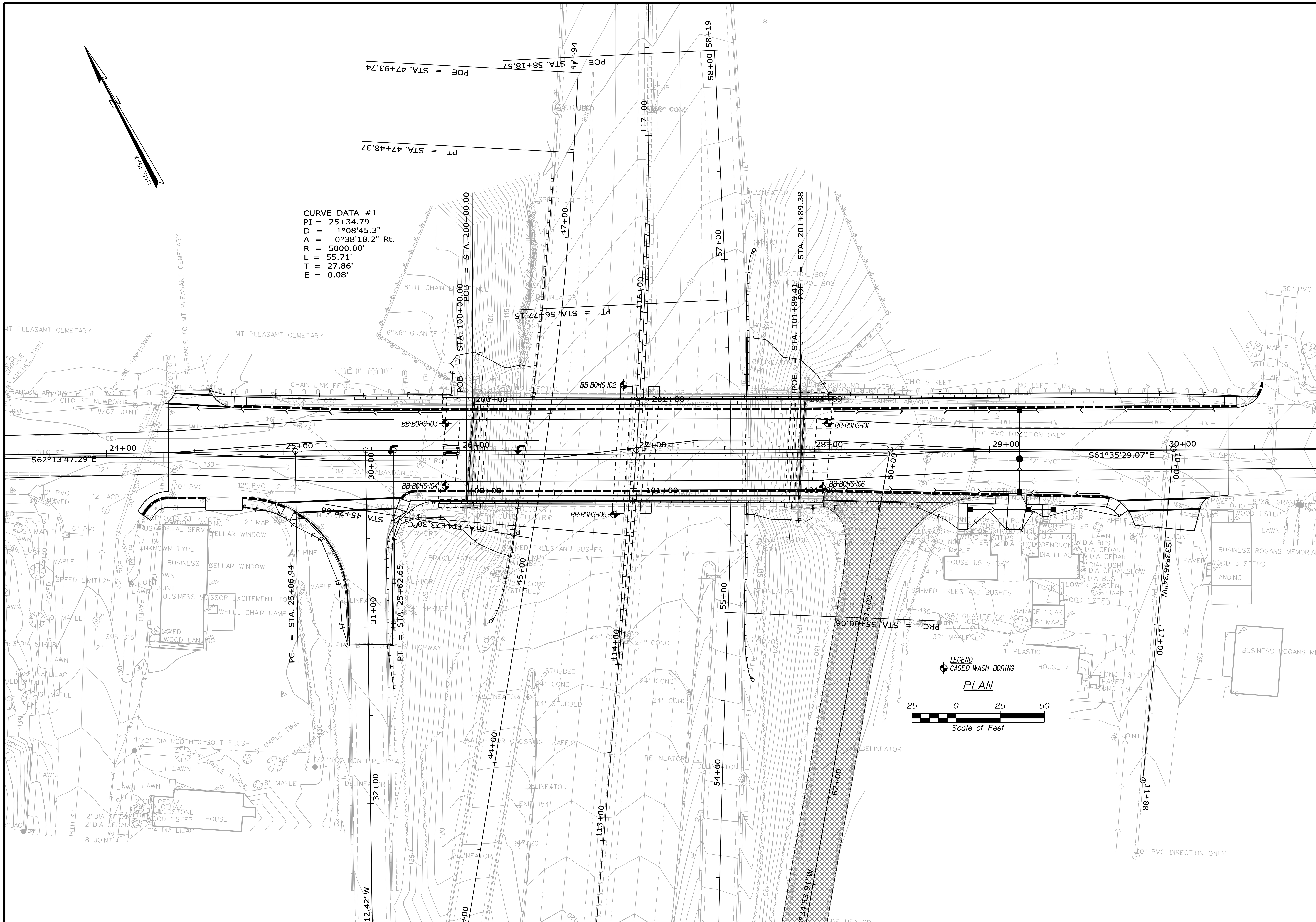


STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

IM-1668(200)E

BRIDGE NO. 5790

WIN
16682.00

BRIDGE PLANS

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED	M.MOREAU	
CHECKED-REVIEWED	T.WHITE	OCT 2009
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

OHIO STREET BRIDGE
OVERPASS I-95

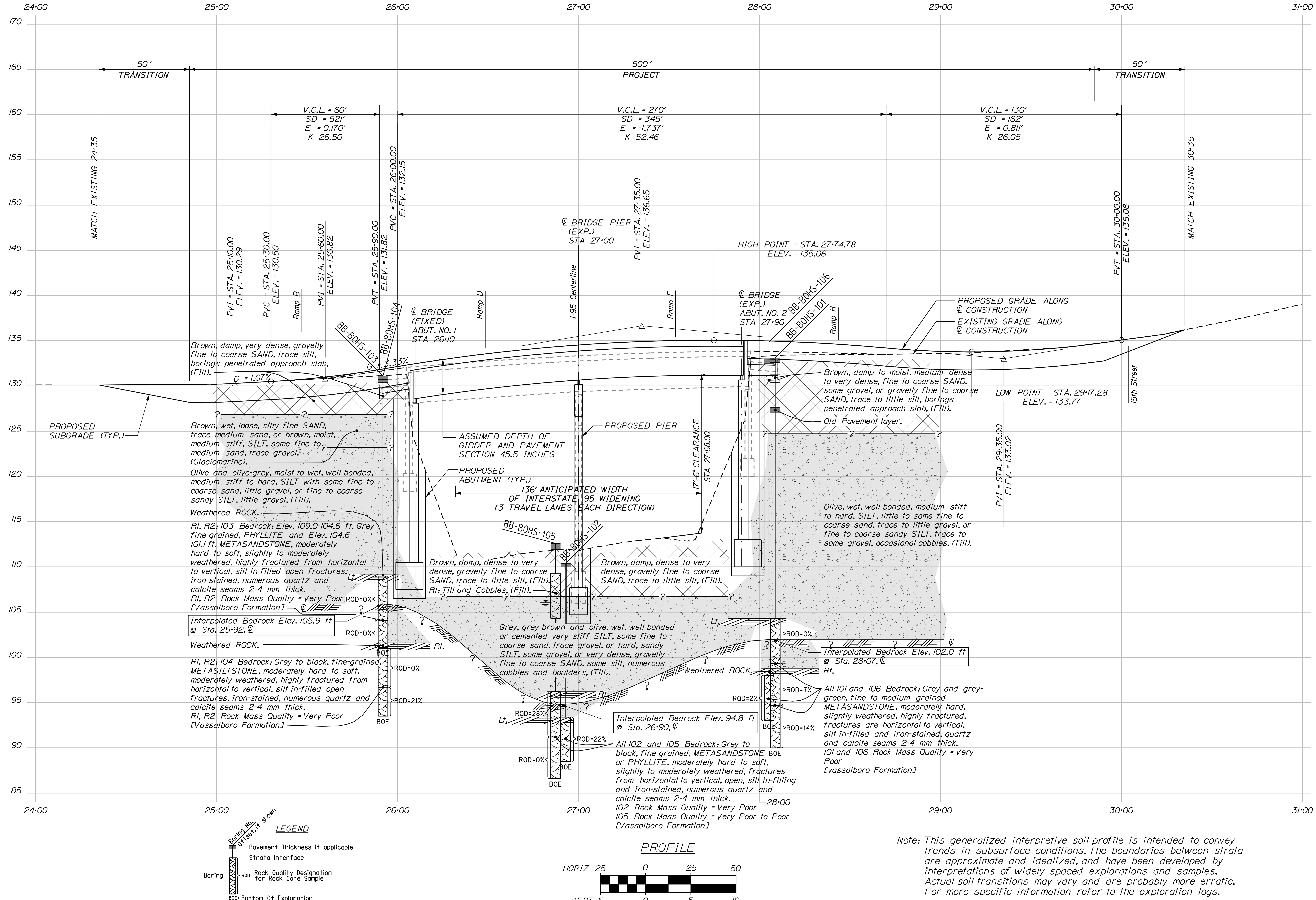
BANGOR PENOBSCOT COUNTY

BORING LOCATION PLAN

SHEET NUMBER

2

OF 5



Note: This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

IM-1668(200)E

WIN 16682.00

BRIDGE PLANS

BRIDGE NO. 5790

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED	T. WHITE	MAY 2011
CHECKED-REVIEWED	M. MOREAU	
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

OHIO STREET BRIDGE
OVERPASS I-95

BANGOR PENOBSCOT COUNTY

INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER

3

OF 5

Filename: ...\00\geotech\msta\007_ISP1.dgn Division: GEOTECH Username: terry.white Date:11/28/2011

Date:11/28/2011 Username: terry.white Division: GEOTECH Filename: ...\msta\008_BORING LOGS1.dgn

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95 | Location: Bangor, Maine | Boring No.: BB-BOHS-103 | WIN: 16682.00

Driller:	MaineDOT-Northern Test Boring	Elevation (ft.)	131.1	Auger ID/OD:	5" Solid Stem
Operator:	Giguere/Giles-Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C-Diedrich D-50	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/20/09-5/20/09	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	25+91.9, 15.1 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0							SSA	130.70	PAVEMENT. —0.40	
	1D	3.6/3	1.00 - 1.30	50(3.6")	---			129.80	Brown, damp, very dense, gravelly fine to medium SAND, (Fill). —1.30	
								128.00	Concrete with re-bar layer. —3.10	
								126.60	Brown, damp, very dense, gravelly fine to medium SAND, (Fill). —4.50	
5	2D	24/24	5.00 - 7.00	2/3/3/2	remark below				Brown, wet, loose, silty fine SAND, trace medium sand, (Glaciomarine).	G#246298 A-4, SM WC=17.5%
								122.10	—9.00	
10	3D	24/20	10.00 - 12.00	5/9/8/12	remark below		30		Olive, wet, very stiff to hard, SILT some fine to coarse sand, little gravel, (Till). Roller coned ahead to 15.0' bgs.	G#246299 A-4, SM WC=12.3%
							16			
	MV		12.00 - 12.00	Would not push			15		Failed 16x32 mm vane attempt.	
							23			
							29			
15	4D	24/22	15.00 - 17.00	8/10/12/12	22	28	OPEN HOLE		Similar to above.	G3246300 A-4, ML WC=10.9%
	MV		17.00 - 17.00	Would not push					Failed 16x32 mm vane attempt.	
20	5D	22.8/18	20.00 - 21.90	11/13/13/50(4.8)	26	33			Similar to above. Weathered Rock in spoon tip.	
								109.20	—21.90 Weathered Bedrock —22.10	
	R1	58.8/58.8	22.10 - 27.00	RQD = 0%			NQ-2	109.00	Top of Bedrock at Elev. 109.2'. R1 Bedrock: Grey, fine-grained PHYLLITE (22.1' to 26.5' bgs), moderately hard to soft, slightly to moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick, one calcite seam 2 cm thick at 24.7' bgs. Rock Mass Quality is Very Poor. [Vassalboro Formation]	
25								104.60	R1:Core Times (min:sec) 22.1-23.1' (3:05) 23.1-24.1' (3:50) 24.1-25.1' (5:30) 25.1-26.1' (6:06) 26.1-27.0' (6:24) 100% Recovery Core Blocked —26.50	
	R2	36/27	27.00 - 30.00	RQD = 0%					R2 Bedrock: Grey, fine-grained METASANDSTONE (26.5' to 30.0' bgs), moderately hard to soft, slightly to moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick. Rock Mass Quality is Very Poor. [Vassalboro Formation] R2:Core Times (min:sec) 27.0-28.0' (3:55) 28.0-29.0' (3:55) 29.0-30.0' (8:18) 75% Recovery Core Blocked	
30								101.10	—30.00 Bottom of Exploration at 30.00 feet below ground surface.	
35										
40										
45										
50										

Remarks:

MaineDOT sampled 1D thru 3D then rig broke down. Using hammer efficiency factor of 0.84, the N60 SPT Blow Counts are: 2D=8, 3D=24

NTB completed the boring with hammer #283 and hammer efficiency factor of 0.76.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1 — Boring No.: BB-BOHS-103

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95 | Location: Bangor, Maine | Boring No.: BB-BOHS-104 | WIN: 16682.00

Driller:	Northern Test Boring	Elevation (ft.)	131.0	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	Diedrich D-50	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/13/09; 12:00-15:45	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	25+91.9, 20.1 Rt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions: D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; MU = Unsuccessful Thin Wall Tube Sample attempt; V = Insitu Vane Shear Test, PP = Pocket Penetrometer; MV = Unsuccessful Insitu Vane Shear Test attempt; R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = weight of 140lb. hammer; WOR/C = weight of rods or casing; WO1P = Weight of one person; S_u = Insitu Field Vane Shear Strength (psf); T_v = Pocket Torvane Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw field SPT N-value; Hammer Efficiency Factor = Annual Calibration Value; N_{60} = SPT N-uncorrected corrected for hammer efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected; $S_{u(lab)}$ = Lab Vane Shear Strength (psf); WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0							SSA	130.40	PAVEMENT. —0.60	
								129.10	Brown, damp, gravelly fine to coarse SAND, trace silt. —1.90	
								128.50	Concrete with re-bar layer. —2.50	
								127.50	Brown, damp, gravelly fine to coarse SAND, trace silt. —3.50	
5	2D	24/24	5.00 - 7.00	3/3/3/3	6	8			Brown, moist, medium stiff SILT, some fine to medium sand, trace gravel (Glaciomarine).	G#246301 A-4, ML WC=28.4%
								123.00	—8.00	
10	3D	24/22	10.00 - 12.00	11/6/12/10	18	23	30		Olive-grey to grey, moist to wet, well banded, very stiff to hard, fine to coarse sandy SILT, little gravel, (Till).	G#246302 A-4, ML WC=11.3%
							57			
	MV		12.00 - 12.00	Would not push			59		Failed 16x32 mm vane attempt.	
							67			
							OPEN HOLE			
15	3D	24/16	15.00 - 17.00	8/11/20/23	31	39				
20	4D	24/14	20.00 - 22.00	11/16/10/14	26	33				G#246303 A-4, SM WC=10.3%
25	5D	24/18	25.00 - 27.00	13/14/14/13	28	35			Olive-grey to grey, moist to wet, well banded, very stiff to hard, fine to coarse sandy SILT, little gravel, (Till).	
								101.60	Weathered ROCK. Roller Coned ahead to 30.0' bgs. —29.40	
30	R1	51.6/24	30.00 - 34.30	RQD = 0%			NQ-2	101.00	—30.00 Top of intact Bedrock at Elev. 101.0'. R1 and R2 Bedrock: Grey to black, fine-grained METASILTSTONE, moderately hard to soft, moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams up to 2 cm thick and numerous after 34.3' bgs (R2). Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 30.0-31.0' (6:00) 31.0-32.0' (5:30) 32.0-33.0' (5:40) 33.0-34.0' (8:24) 34.0-34.3' (3:07) 45% Recovery Core Blocked	
35	R2	38.4/36.4	34.30 - 37.50	RQD = 21%					R2:Core Times (min:sec) 34.3-35.0' (2:00) 35.0-36.0' (3:02) 36.0-37.0' (3:43) 37.0-37.5' (3:06) 95% Recovery Core Blocked	
								93.50	—37.50 Bottom of Exploration at 37.50 feet below ground surface.	
40										
45										
50										

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1 — Boring No.: BB-BOHS-104

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95 | Location: Bangor, Maine | Boring No.: BB-BOHS-102 | WIN: 16682.00

Driller:	Northern Test Boring	Elevation (ft.)	110.4	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	M. Moreau	Rig Type:	Diedrich D-50 Trailer	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/20/09-5/20/09	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	26+92.9, 36.8 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.68		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions: D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; MU = Unsuccessful Thin Wall Tube Sample attempt; V = Insitu Vane Shear Test, PP = Pocket Penetrometer; MV = Unsuccessful Insitu Vane Shear Test attempt; R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = weight of 140lb. hammer; WOR/C = weight of rods or casing; WO1P = Weight of one person; S_u = Insitu Field Vane Shear Strength (psf); T_v = Pocket Torvane Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw field SPT N-value; Hammer Efficiency Factor = Annual Calibration Value; N_{60} = SPT N-uncorrected corrected for hammer efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected; $S_{u(lab)}$ = Lab Vane Shear Strength (psf); WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0							SSA	109.60	PAVEMENT. —0.80	
	1D	24/12	2.00 - 4.00	6/18/18/30	36	41			Brown, damp, dense, gravelly fine to coarse SAND, trace silt, (Fill).	
5	2D	9.6/7	5.00 - 5.80	36/50(3.6")	---		OPEN HOLE	104.60	—5.80 Grey-brown, cemented, very dense, gravelly fine to coarse SAND, some silt, with numerous cobbles and boulders, (Till). Refusal on spoon at 5.8' bgs. Roller Coned ahead to 10.0' bgs. in open hole.	
10	MD	1.2/0	10.00 - 10.10	54(1.2")	---				Failed sample attempt.	
15	3D	1.2/1	15.00 - 15.10	100(1.2")	---				Gravel, trace silt, wash from very dense till with cobbles and boulders. Roller Coned ahead to 17.0'bgs. Drill attitude indicates Bedrock at 17.0' bgs.	
	R1	58.8/48	17.00 - 21.90	RQD = 22%			NQ-2	93.40	—17.00 Top of Bedrock at Elev. 93.4'. R1:Core Times (min:sec) 17.0-18.0' (4:37)	
								92.40	—18.00 R1 Bedrock: Grey, fine-grained, METASANDSTONE (top one foot) and PHYLLITE (18.0' to 21.9' bgs), moderately hard, slightly weathered, fractures from horizontal to 45 degress, close, open with minor silt in filling and iron-staining, quartz seam 19.3-19.7', numerous quartz and calcite seams 2-4 mm thick, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) Con't 18.0-19.0' (5:58) 19.0-20.0' (7:56) 20.0-21.0' (6:43) 21.0-21.9' (5:16) 81% Recovery	
20								88.50	—21.90 Bottom of Exploration at 21.90 feet below ground surface.	
25										

Remarks:

Auto Hammer #149

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1 — Boring No.: BB-BOHS-102

Maine Department of Transportation — Soil/Rock Exploration Log — US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95 | Location: Bangor, Maine | Boring No.: BB-BOHS-105 | WIN: 16682.00

Driller:	MaineDOT	Elevation (ft.)	112.6	Auger ID/OD:	5" Solid Stem
Operator:	Giguere/Giles	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/20/09; 06:00-9:30	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	26+87.3, 36.5 Rt.	Casing ID/OD:	HW	Water Level*:	6.5' bgs.
Hammer Efficiency Factor: 0.84		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions: D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample attempt; U = Thin Wall Tube Sample; MU = Unsuccessful Thin Wall Tube Sample attempt; V = Insitu Vane Shear Test, PP = Pocket Penetrometer; MV = Unsuccessful Insitu Vane Shear Test attempt; R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = weight of 140lb. hammer; WOR/C = weight of rods or casing; WO1P = Weight of one person; S_u = Insitu Field Vane Shear Strength (psf); T_v = Pocket Torvane Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw field SPT N-value; Hammer Efficiency Factor = Annual Calibration Value; N_{60} = SPT N-uncorrected corrected for hammer efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected; $S_{u(lab)}$ = Lab Vane Shear Strength (psf); WC = water content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
0							SSA	111.90	PAVEMENT. —0.70	
	1D	15.6/12	2.00 - 3.30	13/28/50(3.6")	---				Brown, damp, very dense, gravelly, fine to coarse SAND, little silt.	G#246304 A-1-b, SM WC=4.9%
	R1	60/4	3.30 - 8.30	RQD = N/A%			50 NQ-2	108.60	—4.00 R1:Fill, Till and Cobbles. R1:Core Times (min:sec) 3.3-4.3' (1:33) 4.3-5.3' (1:45) 5.3-6.3' (1:46) 6.3-7.3' (1:45) 7.3-8.3' (1:12) Put sample in cup.	
							13			
5							4			
							10			
							6			
	2D	24/17	8.30 - 10.30	10/8/9/13	17	24	26		Olive, wet, well bonded, very stiff, SILT, some fine to coarse sand, trace gravel, cobbles, (Till).	G#246305 A-4, ML WC=12.4%
							37			
10							44			
							55			
							69	99.60	—13.00	
							83			
							47			
15	3D	16.8/16.8	15.00 - 16.40	10/32/50(4.8")	---		68		Grey, wet, cemented, hard, fine to coarse sandy SILT, some gravel, cobbles, (Till). Weathered Rock in spoon tip. a40 blows for 0.4'.	G#246306 A-4, SM WC=12.3%
	R2	60/60	16.40 - 21.40	RQD = 28%			a40 NQ-2	96.20	—16.40 Top of Bedrock at Elev. 96.2'. R2 and R3 Bedrock: Grey to black, fine-grained METASANDSTONE, moderately hard to soft, moderately weathered, moderately to highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick. Rock Mass Quality is Very Poor to Poor. [Vassalboro Formation] R2:Core Times (min:sec) 16.4-17.4' (5:44) 17.4-18.4' (3:35) 18.4-19.4' (3:40) 19.4-20.4' (3:47) 20.4-21.4' (2:50) 100% Recovery	
20	R3	55.2/55.2	21.40 - 26.00	RQD = 0%					R3:Core Times (min:sec) 21.4-22.4' (3:48) 22.4-23.4' (3:15) 23.4-24.4' (4:55) 24.4-25.4' (4:17) 25.4-26.0' (4:12) 100% Recovery Core Blocked	
25								86.60	—26.00 Bottom of Exploration at 26.00 feet below ground surface.	
30										
35										
40										
45										
50										

Remarks:

300# down pressure on core barrel.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1 — Boring No.: BB-BOHS-105

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

IM-1668(200)E

WIN 16682.00

BRIDGE PLANS

BRIDGE NO. 5790

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED	M.MOREAU	MAY 2011
CHECKED-REVIEWED	T.WHITE	
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

OHIO STREET BRIDGE
OVERPASS I-95

BANGOR PENOBSCOT COUNTY

BORING LOGS

SHEET NUMBER 4 OF 5

Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-101
WIN: 16682.00

Driller:	Northern Test Boring	Elevation (ft.)	133.1	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	Diedrich D-50 Trailer	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/12/09; 06:45-11:30	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	28+08.6, 14.9 Lt.	Casing ID/OD:	HW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
0	1D	15.6/10	0.50 - 1.80	37/37/50(3.6")	---		SSA	132.60
								131.30
								130.40
5	2D	24/18	5.00 - 7.00	12/43/16/11	59	75		127.60
								127.10
								125.10
10	3D	24/20	10.00 - 12.00	4/3/3/4	6	8	40	
							124	
							86	
							150	
							194	119.10
15	4D	24/20	15.00 - 17.00	10/13/20/20	33	42	OPEN HOLE	
	MV		17.00 - 17.00	Would Not Push				
20	5D	24/20	20.00 - 22.00	12/16/20/36	36	46		113.10
25	6D	24/16	25.00 - 27.00	8/9/19/25	28	35		
	R1	60/35	28.80 - 33.80	RQD = 0%			NQ-2	104.30
30								
	R2	55.2/40	33.80 - 38.40	RQD = 7%				
35								
	R3	56.4/56.4	38.40 - 43.10	RQD = 14%				
40								90.00
45								
50								

Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
PAVEMENT. (0.50)	
Brown, damp, very dense, fine to coarse SAND, some gravel, little silt. (1.80)	G#246294 A-1-a, SM WC=3.2%
Concrete layer with re-bar from 1.8-2.7' bgs. (2.70)	
Similar to above. (5.50)	
Old Pavement layer from 5.5-6.0' bgs. (6.00)	
(8.00)	
Olive, wet, mottled, medium stiff, fine to coarse sandy SILT, trace gravel, (Till). (14.00)	G#246295 A-4, ML WC=19.8%
Olive, wet, well bonded, hard, SILT, some fine to coarse sand, trace to little gravel, (Till).	G#246296 A-4, ML WC=11.4%
Failed 16x32 mm vane attempt. (20.00)	
Similar to above, but with occasional cobbles.	
Olive, wet, well bonded, hard, SILT, some fine to coarse sand, trace to little gravel, occasional cobbles, (Till). (28.80)	G#246297 A-4, ML WC=11.0%
Top of Bedrock at Elev. 104.3'. R1, R2, R3 Bedrock: Grey, fine-grained METASANDSTONE, moderately hard, slightly weathered, highly fractured (core is largely friable), fractures are open, silt in-filled, numerous quartz and calcite seams 2-4 mm thick, less fractured from 34.3' to 36.8' bgs, highly weathered zone between 36.8' and 38.4' bgs, R3 is moderately fractured with fractures that follow bedding planes from horizontal to 45 degrees above horizontal, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 28.8-29.8' (2:36) 29.8-30.8' (3:35) 30.8-31.8' (3:06) 31.8-32.8' (4:02) 32.8-33.8' (3:02) 58% Recovery R2:Core Times (min:sec) 33.8-34.8' (2:50) 34.8-35.8' (2:05) 35.8-36.8' (2:50) 36.8-37.8' (4:55) 37.8-38.4' (2:06) 80% Recovery Core Blocked R3:Core Times (min:sec) 38.4-39.4' (2:55) 39.4-40.4' (3:22) 40.4-41.4' (3:03) 41.4-42.4' (3:40) 42.4-43.1' (2:45) 100% Recovery Core Blocked (43.10)	
Bottom of Exploration at 43.10 feet below ground surface.	

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1

Boring No.: BB-BOHS-101

Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-106
WIN: 16682.00

Driller:	Northern Test Boring	Elevation (ft.)	133.0	Auger ID/OD:	5" Solid Stem
Operator:	Mike/Mike	Datum:	NAVD 88	Sampler:	Standard Split Spoon
Logged By:	B. Wilder	Rig Type:	Diedrich D-50	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	5/13/09; 06:45-11:30	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	28+05.3, 21.8 Rt.	Casing ID/OD:	NW	Water Level*:	None Observed
Hammer Efficiency Factor: 0.76		Hammer Type:	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
0							SSA	132.45
								131.10
								130.00
5	1D	24/20	5.00 - 7.00	7/13/11/13	24	30		
								123.50
10	2D	24/18	10.00 - 12.00	6/8/8/6	16	20	62	
							55	
	MV		12.00 - 12.00	Would not push			98	
							132	119.50
							133	
15	3D	24/20	15.00 - 17.00	11/15/18/19	33	42	OPEN HOLE	
20	4D	24/19	20.00 - 22.00	8/8/14/15	22	28		
25	5D	24/18	25.00 - 27.00	7/17/11/9	28	35		
								104.50
30	6D	24/20	30.00 - 32.00	9/12/22/19	34	43		
								98.80
35	R1	60/43	35.00 - 40.00	RQD = 2%			NQ-2	98.00
40								93.00
45								
50								

Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class
PAVEMENT. (0.55)	
Brown, damp, gravelly fine to medium SAND, trace silt, (Fill). (1.90)	
Concrete layer with re-bar from 1.9-3.0' bgs. (3.00)	
Brown, moist, medium dense, gravelly fine to coarse SAND, little silt, (Old Pavement, Fill). (9.50)	
Olive, wet, very stiff, fine to coarse sandy SILT, some gravel, (Till).	G#246307 A-4, SM WC=11.1%
Failed 16x32 mm vane attempt. (13.50)	
Olive, wet, well bonded, very stiff to hard, SILT, some fine to coarse sand, little gravel, (Till).	G#246308 A-4, ML WC=9.4%
	G#24630 A-4, ML WC=11.2%
Olive, wet, well bonded, very stiff to hard, SILT, some fine to coarse sand, little gravel, (Till). (28.50)	
Olive, wet, well bonded, hard, SILT, little fine to coarse sand, trace gravel, (Till).	G#246310 A-4, ML WC=14.4%
Cobble from 33.0-33.5' bgs. (34.20)	
Weathered Rock, Roller Coned ahead to 35.0' bgs. (35.00)	
Top of intact Bedrock at Elev. 98.0'. R1 Bedrock: Grey-green, fine to medium grained, METASANDSTONE, moderately hard, highly fractured with open fractures oriented from horizontal to vertical, very slight weathering, with minor silt in-filling and iron staining along fractures, one silt seam approximately 1-2 cm thick at 36.9' bgs, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 35.0-36.0' (3:00) 36.0-37.0' (4:30) 37.0-38.0' (4:00) 38.0-39.0' (2:55) 39.0-40.0' (2:40) 72% Recovery (40.00)	
Bottom of Exploration at 40.00 feet below ground surface.	

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1

Boring No.: BB-BOHS-106

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

IM-1668(200)E

WIN 16682.00

BRIDGE PLANS

BRIDGE NO. 5790

	BY	DATE
PROJ. MANAGER		
DESIGN-DETAILED	M.MOREAU	T.WHITE MAY 2011
CHECKED-REVIEWED		
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

OHIO STREET BRIDGE
OVERPASS I-95

BANGOR
PENOBSCOT COUNTY

BORING LOGS

SHEET NUMBER

5

OF 5

Appendix A

Boring Logs

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations: (in this order)

Color (Munsell color chart)
Moisture (dry, damp, moist, wet, saturated)
Density/Consistency (from above right hand side)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc., if applicable)
Cementation (weak, moderate, or strong, if applicable, ASTM D 2488)
Geologic Origin (till, marine clay, alluvium, etc.)
Unified Soil Classification Designation
Groundwater level

Maine Department of Transportation
Geotechnical Section
Key to Soil and Rock Descriptions and Terms
Field Identification Information

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Consistency is rated according to standard penetration resistance.

Modified Burmister System

Descriptive Term	Portion of Total
trace	0% - 10%
little	11% - 20%
some	21% - 35%
adjective (e.g. sandy, clayey)	36% - 50%

Density of Cohesionless Soils	Standard Penetration Resistance N-Value (blows per foot)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.

Consistency of Cohesive soils	SPT N-Value blows per foot	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	WOH, WOR, WOP, <2	0 - 250	Fist easily Penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	5 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	9 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	16 - 30	2000 - 4000	Indented by thumbnail
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

$$RQD = \frac{\text{sum of the lengths of intact pieces of core* > 100 mm}}{\text{length of core advance}}$$

*Minimum NQ rock core (1.88 in. OD of core)

Correlation of RQD to Rock Mass Quality

Rock Mass Quality	RQD
Very Poor	<25%
Poor	26% - 50%
Fair	51% - 75%
Good	76% - 90%
Excellent	91% - 100%

Desired Rock Observations: (in this order)

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Lithology (igneous, sedimentary, metamorphic, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90)
- -spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m)
- -tightness (tight, open or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock mass quality (very poor, poor, etc.)
ref: AASHTO Standard Specification for Highway Bridges 17th Ed. Table 4.4.8.1.2A
Recovery

Sample Container Labeling Requirements:

PIN	Blow Counts
Bridge Name / Town	Sample Recovery
Boring Number	Date
Sample Number	Personnel Initials
Sample Depth	

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Ohio Street Overpass of I-95	**Boring No.:**	BB-BOHS-101		
Location:	Bangor, Maine	**WIN:**	16682.00		
Driller:	Northern Test Boring	**Elevation (ft.)**	133.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50 Trailer	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/12/09; 06:45-11:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	28+08.6, 14.9 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒	Hydraulic ☐	Rope & Cathead ☐

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	15.6/10	0.50 - 1.80	37/37/50(3.6")	---		SSA	132.60		PAVEMENT. 0.50 Brown, damp, very dense, fine to coarse SAND, some gravel, little silt.	G#246294 A-1-a, SM WC=3.2%
								131.30		1.80 Concrete layer with re-bar from 1.8-2.7' bgs.	
								130.40		2.70	
5	2D	24/18	5.00 - 7.00	12/43/16/11	59	75		127.60		Similar to above. 5.50	
								127.10		Old Pavement layer from 5.5-6.0' bgs. 6.00	
								125.10		8.00	
10	3D	24/20	10.00 - 12.00	4/3/3/4	6	8	40			Olive, wet, mottled, medium stiff, fine to coarse sandy SILT, trace gravel, (Till).	G#246295 A-4, ML WC=19.8%
							124				
							86				
							150				
							194	119.10		14.00	
15	4D	24/20	15.00 - 17.00	10/13/20/20	33	42	OPEN HOLE			Olive, wet, well bonded, hard, SILT, some fine to coarse sand, trace to little gravel, (Till).	G#246296 A-4, ML WC=11.4%
	MV		17.00 - 17.00	Would Not Push						Failed 16x32 mm vane attempt.	
20	5D	24/20	20.00 - 22.00	12/16/20/36	36	46		113.10		20.00 Similar to above, but with occasional cobbles.	
25											

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Ohio Street Overpass of I-95 **Location:** Bangor, Maine	**Boring No.:** BB-BOHS-101 **WIN:** 16682.00

Driller:	Northern Test Boring	**Elevation (ft.)**	133.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50 Trailer	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/12/09; 06:45-11:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	28+08.6, 14.9 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_V = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	6D	24/16	25.00 - 27.00	8/9/19/25	28	35				Olive, wet, well bonded, hard, SILT, some fine to coarse sand, trace to little gravel, occasional cobbles, (Till).	G#246297 A-4, ML WC=11.0%
	R1	60/35	28.80 - 33.80	RQD = 0%			NQ-2	104.30		28.80	
30										Top of Bedrock at Elev. 104.3'. R1, R2, R3 Bedrock: Grey, fine-grained METASANDSTONE, moderately hard, slightly weathered, highly fractured (core is largely friable), fractures are open, silt in-filled, numerous quartz and calcite seams 2-4 mm thick, less fractured from 34.3' to 36.8' bgs, highly weathered zone between 36.8' and 38.4' bgs, R3 is moderately fractured with fractures that follow bedding planes from horizontal to 45 degrees above horizontal, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) 28.8-29.8' (2:36) 29.8-30.8' (3:35) 30.8-31.8' (3:06) 31.8-32.8' (4:02) 32.8-33.8' (3:02) 58% Recovery	
	R2	55.2/40	33.80 - 38.40	RQD = 7%							
35										R2:Core Times (min:sec) 33.8-34.8' (2:50) 34.8-35.8' (2:05) 35.8-36.8' (2:50) 36.8-37.8' (4:55) 37.8-38.4' (2:06) 80% Recovery Core Blocked	
	R3	56.4/56.4	38.40 - 43.10	RQD = 14%							
40										R3:Core Times (min:sec) 38.4-39.4' (2:55) 39.4-40.4' (3:22) 40.4-41.4' (3:03) 41.4-42.4' (3:40) 42.4-43.1' (2:45) 100% Recovery Core Blocked	
								90.00		43.10 **Bottom of Exploration at 43.10 feet below ground surface.**	
45											
50											

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-102
WIN: 16682.00

Driller:	Northern Test Boring	**Elevation (ft.)**	110.4	**Auger ID/OD:**	5" Solid Stem
Operator:	Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	M. Moreau	**Rig Type:**	Diedrich D-50 Trailer	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/09-5/20/09	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	26+92.9, 36.8 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.68	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	109.60		PAVEMENT. — 0.80	
	1D	24/12	2.00 - 4.00	6/18/18/30	36	41				Brown, damp, dense, gravelly fine to coarse SAND, trace silt, (Fill).	
5	2D	9.6/7	5.00 - 5.80	36/50(3.6")	---		OPEN HOLE	104.60		— 5.80 Grey-brown, cemented, very dense, gravelly fine to coarse SAND, some silt, with numerous cobbles and boulders, (Till). Refusal on spoon at 5.8' bgs. Roller Coned ahead to 10.0' bgs. in open hole.	
10	MD	1.2/0	10.00 - 10.10	54(1.2")	---					Failed sample attempt.	
15	3D	1.2/1	15.00 - 15.10	100(1.2")	---			93.40		Gravel, trace silt, wash from very dense till with cobbles and boulders. Roller Coned ahead to 17.0'bgs. Drill attitude indicates Bedrock at 17.0' bgs. — 17.00	
	R1	58.8/48	17.00 - 21.90	RQD = 22%			NQ-2	92.40		Top of Bedrock at Elev. 93.4'. R1:Core Times (min:sec) 17.0-18.0' (4:37) — 18.00	
20								88.50		R1 Bedrock: Grey, fine-grained, METASANDSTONE (top one foot) and PHYLLITE (18.0' to 21.9' bgs), moderately hard, slightly weathered, fractures from horizontal to 45 degress, close, open with minor silt in filling and iron-staining, quartz seam 19.3-19.7', numerous quartz and calcite seams 2-4 mm thick, Rock Mass Quality is Very Poor. [Vassalboro Formation] R1:Core Times (min:sec) Con't 18.0-19.0' (5:58) 19.0-20.0' (7:56) 20.0-21.0' (6:43) 21.0-21.9' (5:16) 81% Recovery — 21.90	
25										**Bottom of Exploration at 21.90 feet below ground surface.**	

Remarks:

Auto Hammer #149

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Ohio Street Overpass of I-95			**Boring No.:**	BB-BOHS-103
Location:	Bangor, Maine			**WIN:**	16682.00
Driller:	MaineDOT-Northern Test Boring	**Elevation (ft.)**	131.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Giguere/Giles-Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C-Diedrich D-50	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/09-5/20/09	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	25+91.9, 15.1 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	130.70		PAVEMENT. 0.40	
	1D	3.6/3	1.00 - 1.30	50(3.6")	---			129.80		Brown, damp, very dense, gravelly fine to medium SAND, (Fill). 1.30	
										Concrete with re-bar layer.	
								128.00		3.10 Brown, damp, very dense, gravelly fine to medium SAND, (Fill).	
								126.60		4.50	
5	2D	24/24	5.00 - 7.00	2/3/3/2	remark below					Brown, wet, loose, silty fine SAND, trace medium sand, (Glaciomarine).	G#246298 A-4, SM WC=17.5%
								122.10		9.00	
10	3D	24/20	10.00 - 12.00	5/9/8/12	remark below		30			Olive, wet, very stiff to hard, SILT some fine to coarse sand, little gravel, (Till).	G#246299 A-4, SM WC=12.3%
							16			Roller coned ahead to 15.0' bgs.	
	MV		12.00 - 12.00	Would not push			15				
							23			Failed 16x32 mm vane attempt.	
							29				
15	4D	24/22	15.00 - 17.00	8/10/12/12	22	28	OPEN HOLE			Similar to above.	G3246300 A-4, ML WC=10.9%
	MV		17.00 - 17.00	Would not push						Failed 16x32 mm vane attempt.	
20	5D	22.8/18	20.00 - 21.90	11/13/13/50(4.8)	26	33				Similar to above. Weathered Rock in spoon tip.	
								109.20		21.90	
	R1	58.8/58.8	22.10 - 27.00	RQD = 0%			NQ-2	109.00		Weathered Bedrock 22.10	
										Top of Bedrock at Elev. 109.2'. R1 Bedrock: Grey, fine-grained PHYLLITE (22.1' to 26.5' bgs), moderately hard to soft, slightly to moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled,	
25											

Remarks:

MaineDOT sampled 1D thru 3D then rig broke down. Using hammer efficiency factor of 0.84, the N60 SPT Blow Counts Are: 2D=8, 3D=24

NTB completed the boring with hammer #283 and hammer efficency factor of 0.76.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Boring No.: BB-BOHS-103

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Ohio Street Overpass of I-95	**Location:**	Bangor, Maine	**Boring No.:**	BB-BOHS-103
				WIN:	16682.00
Driller:	MaineDOT-Northern Test Boring	**Elevation (ft.)**	131.1	**Auger ID/OD:**	5" Solid Stem
Operator:	Giguere/Giles-Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C-Diedrich D-50	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/09-5/20/09	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	25+91.9, 15.1 Lt.	**Casing ID/OD:**	HW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										some iron staining, numerous quartz and calcite seams 2-4 mm thick, one calcite seam 2 cm thick at 24.7' bgs, Rock Mass Quality is Very Poor. [Vassalboro Formation]	
								104.60		R1:Core Times (min:sec) 22.1-23.1' (3:05) 23.1-24.1'(3:50) 24.1-25.1' (5:30) 25.1-26.1' (6:06) 26.1-27.0' (6:24) 100% Recovery Core Blocked	
	R2	36/27	27.00 - 30.00	RQD = 0%							
										26.50	
30								101.10		R2 Bedrock: Grey, fine-grained METASANDSTONE (26.5' to 30.0' bgs), moderately hard to soft, slightly to moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick, Rock Mass Quality is Very Poor. [Vassalboro Formation] R2:Core Times (min:sec) 27.0-28.0' (3:55) 28.0-29.0' (3:55) 29.0-30.0' (8:18) 75% Recovery Core Blocked	
35										30.00 **Bottom of Exploration at 30.00 feet below ground surface.**	
40											
45											
50											

Remarks:

MaineDOT sampled 1D thru 3D then rig broke down. Using hammer efficiency factor of 0.84, the N60 SPT Blow Counts Are: 2D=8, 3D=24

NTB completed the boring with hammer #283 and hammer efficency factor of 0.76.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-104
WIN: 16682.00

Driller:	Northern Test Boring	**Elevation (ft.)**	131.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/13/09; 12:00-15:45	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	25+91.9, 20.1 Rt.	**Casing ID/OD:**	NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	130.40		PAVEMENT. 0.60	
								129.10		Brown, damp, gravelly fine to coarse SAND, trace silt. 1.90	
								128.50		Concrete with re-bar layer. 2.50	
								127.50		Brown, damp, gravelly fine to coarse SAND, trace silt. 3.50	
5	1D	24/24	5.00 - 7.00	3/3/3/3	6	8				Brown, moist, medium stiff SILT, some fine to medium sand, trace gravel (Glaciomarine).	G#246301 A-4, ML WC=28.4%
								123.00		8.00	
10	2D	24/22	10.00 - 12.00	11/6/12/10	18	23	30			Olive-grey to grey, moist to wet, well bonded, very stiff to hard, fine to coarse sandy SILT, little gravel, (Till).	G#246302 A-4, ML WC=11.3%
							57				
	MV		12.00 - 12.00	Would not push			59			Failed 16x32 mm vane attempt.	
							67				
							OPEN HOLE				
15	3D	24/16	15.00 - 17.00	8/11/20/23	31	39					
20	4D	24/14	20.00 - 22.00	11/16/10/14	26	33					G#246303 A-4, SM WC=10.3%
25											

Remarks:

Auto Hammer #283

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Ohio Street Overpass of I-95	**Location:**	Bangor, Maine	**Boring No.:**	BB-BOHS-104
				WIN:	16682.00
Driller:	Northern Test Boring	**Elevation (ft.)**	131.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/13/09; 12:00-15:45	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	25+91.9, 20.1 Rt.	**Casing ID/OD:**	NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	5D	24/18	25.00 - 27.00	13/14/14/13	28	35				Olive-grey to grey, moist to wet, well bonded, very stiff to hard, fine to coarse sandy SILT, little gravel, (Till).	
								101.60		29.40	
										Weathered ROCK. Roller Coned ahead to 30.0' bgs.	
30								101.00		30.00	
	R1	51.6/24	30.00 - 34.30	RQD = 0%			NQ-2			Top of intact Bedrock at Elev. 101.0'. R1 and R2 Bedrock: Grey to black, fine-grained METASILTSTONE, moderately hard to soft, moderately weathered, highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams up to 2 cm thick and numerous after 34.3' bgs (R2), Rock Mass Quality is Very Poor. [Vassalboro Formation]	
	R2	38.4/36.4	34.30 - 37.50	RQD = 21%						R1:Core Times (min:sec) 30.0-31.0' (6:00) 31.0-32.0' (5:30) 32.0-33.0' (5:40) 33.0-34.0' (8:24) 34.0-34.3' (3:07) 45% Recovery Core Blocked	
35											
								93.50		R2:Core Times (min:sec) 34.3-35.0' (2:00) 35.0-36.0' (3:02) 36.0-37.0' (3:43) 37.0-37.5' (3:06) 95% Recovery Core Blocked	
										37.50	
										Bottom of Exploration at 37.50 feet below ground surface.	
40											
45											
50											

Remarks:

Auto Hammer #283

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95		**Boring No.:**	BB-BOHS-105
Location: Bangor, Maine		**WIN:**	16682.00

Driller:	MaineDOT	**Elevation (ft.)**	112.6	**Auger ID/OD:**	5" Solid Stem
Operator:	Giguere/Giles	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/09; 06:00-9:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	26+87.3, 36.5 Rt.	**Casing ID/OD:**	HW	**Water Level*:**	6.5' bgs.
Hammer Efficiency Factor:	0.84	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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MD = Unsuccessful Split Spoon Sample attempt
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V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Sample Information

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)
0							SSA	
								111.90
	1D	15.6/12	2.00 - 3.30	13/28/50(3.6")	---			
	R1	60/4	3.30 - 8.30	RQD = N/A%			50 NQ-2	108.60
							13	
5							4	
							10	
							6	
	2D	24/17	8.30 - 10.30	10/8/9/13	17	24	26	
							37	
10							44	
							55	
							69	99.60
							83	
							47	
15	3D	16.8/16.8	15.00 - 16.40	10/32/50(4.8")	---		68	
	R2	60/60	16.40 - 21.40	RQD = 28%			a40 NQ-2	96.20
20								
	R3	55.2/55.2	21.40 - 26.00	RQD = 0%				
25								

Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
PAVEMENT. —0.70	
Brown, damp, very dense, gravelly, fine to coarse SAND, little silt. —4.00	G#246304 A-1-b, SM WC=4.9%
R1:Fill, Till and Cobbles. R1:Core Times (min:sec) 3.3-4.3' (1:33) 4.3-5.3' (1:45) 5.3-6.3' (1:46) 6.3-7.3' (1:45) 7.3-8.3' (1:12) Put sample in cup.	
Olive, wet, well bonded, very stiff, SILT, some fine to coarse sand, trace gravel, cobbles, (Till). —13.00	G#246305 A-4, ML WC=12.4%
Grey, wet, cemented, hard, fine to coarse sandy SILT, some gravel, cobbles, (Till). Weathered Rock in spoon tip. a40 blows for 0.4'. —16.40	G#246306 A-4, SM WC=12.3%
Top of Bedrock at Elev. 96.2'. R2 and R3 Bedrock: Grey to black, fine-grained METASANDSTONE, moderately hard to soft, moderately weathered, moderately to highly fractured from horizontal to vertical, fractures are open, silt in-filled, some iron staining, numerous quartz and calcite seams 2-4 mm thick, Rock Mass Quality is Very Poor to Poor. [Vassalboro Formation] R2:Core Times (min:sec) 16.4-17.4' (5:44) 17.4-18.4' (3:35) 18.4-19.4' (3:40) 19.4-20.4' (3:47) 20.4-21.4' (2:50) 100% Recovery R3:Bedrock: R3:Core Times (min:sec) 21.4-22.4' (3:48)	

Remarks:

300# down pressure on core barrel.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Ohio Street Overpass of I-95
Location: Bangor, Maine

Boring No.: BB-BOHS-105
WIN: 16682.00

Driller:	MaineDOT	**Elevation (ft.)**	112.6	**Auger ID/OD:**	5" Solid Stem
Operator:	Giguere/Giles	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/09; 06:00-9:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	26+87.3, 36.5 Rt.	**Casing ID/OD:**	HW	**Water Level*:**	6.5' bgs.

Hammer Efficiency Factor: 0.84 **Hammer Type:** Automatic ☒ Hydraulic ☐ Rope & Cathead ☐

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25								86.60		22.4-23.4' (3:15) 23.4-24.4' (4:55) 24.4-25.4' (4:17) 25.4-26.0' (4:12) 100% Recovery Core Blocked	
										26.00	
										Bottom of Exploration at 26.00 feet below ground surface.	
30											
35											
40											
45											
50											

Remarks:

300# down pressure on core barrel.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Ohio Street Overpass of I-95			**Boring No.:**	BB-BOHS-106
Location:	Bangor, Maine			**WIN:**	16682.00
Driller:	Northern Test Boring	**Elevation (ft.)**	133.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/13/09; 06:45-11:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	28+05.3, 21.8 Rt.	**Casing ID/OD:**	NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	132.45	[graphic log]	PAVEMENT. — 0.55 — Brown, damp, gravelly fine to medium SAND, trace silt, (Fill).	
								131.10		— 1.90 — Concrete layer with re-bar from 1.9-3.0' bgs.	
								130.00		— 3.00 —	
5	1D	24/20	5.00 - 7.00	7/13/11/13	24	30				Brown, moist, medium dense, gravelly fine to coarse SAND, little silt, (Old Pavement, Fill).	
								123.50		— 9.50 —	
10	2D	24/18	10.00 - 12.00	6/8/8/6	16	20	62			Olive, wet, very stiff, fine to coarse sandy SILT, some gravel, (Till).	G#246307 A-4, SM WC=11.1%
							55				
	MV		12.00 - 12.00	Would not push			98			Failed 16x32 mm vane attempt.	
							132	119.50		— 13.50 —	
							133				
15	3D	24/20	15.00 - 17.00	11/15/18/19	33	42	OPEN HOLE			Olive, wet, well bonded, very stiff to hard, SILT, some fine to coarse sand, little gravel, (Till).	G#246308 A-4, ML WC=9.4%
20	4D	24/19	20.00 - 22.00	8/8/14/15	22	28					G#24630 A-4, ML WC=11.2%
25											

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Ohio Street Overpass of I-95	**Boring No.:**	BB-BOHS-106		
Location:	Bangor, Maine	**WIN:**	16682.00		
Driller:	Northern Test Boring	**Elevation (ft.)**	133.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Mike/Mike	**Datum:**	NAVD 88	**Sampler:**	Standard Split Spoon
Logged By:	B. Wilder	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/13/09; 06:45-11:30	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	28+05.3, 21.8 Rt.	**Casing ID/OD:**	NW	**Water Level*:**	None Observed
Hammer Efficiency Factor:	0.76	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
S_u = Insitu Field Vane Shear Strength (psf)
T_v = Pocket Torvane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
N_{60} = SPT N-uncorrected corrected for hammer efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	5D	24/18	25.00 - 27.00	7/17/11/9	28	35				Olive, wet, well bonded, very stiff to hard, SILT, some fine to coarse sand, little gravel, (Till).	
								104.50		28.50	
30	6D	24/20	30.00 - 32.00	9/12/22/19	34	43				Olive, wet, well bonded, hard, SILT, little fine to coarse sand, trace gravel, (Till).	G#246310 A-4, ML WC=14.4%
										Cobble from 33.0-33.5' bgs.	
								98.80		34.20 Weathered Rock. Roller Coned ahead to 35.0' bgs.	
35	R1	60/43	35.00 - 40.00	RQD = 2%			NQ-2	98.00		35.00 Top of intact Bedrock at Elev. 98.0'. R1 Bedrock: Grey-green, fine to medium grained, METASANDSTONE, moderately hard, highly fractured with open fractures oriented from horizontal to vertical, very slight weathering, with minor silt in-filling and iron staining along fractures, one silt seam approximately 1-2 cm thick at 36.9' bgs, Rock Mass Quality is Very Poor. [Vassalboro Formation]	
										R1:Core Times (min:sec) 35.0-36.0' (3:00) 36.0-37.0' (4:30) 37.0-38.0' (4:00) 38.0-39.0' (2:55) 39.0-40.0' (2:40) 72% Recovery	
40								93.00		40.00	
										Bottom of Exploration at 40.00 feet below ground surface.	
45											
50											

Remarks:

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Appendix B

Laboratory Test Data

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Bangor   Project Number: 16682.00

Boring & Sample Identification Number	Station (Feet)	Offset (Feet)	Depth (Feet)	Reference Number	G.S.D.C. Sheet	W.C. %	L.L.	P.I.	Classification		
									Unified	AASHTO	Frost
BB-BOHS-101, 1D	28+08.6	14.9 Lt.	0.50-1.8	246294	1	3.2			SM	A-1-a	II
BB-BOHS-101, 3D	28+08.6	14.9 Lt.	10.0-12.0	246295	1	19.8			ML	A-4	IV
BB-BOHS-101, 4D	28+08.6	14.9 Lt.	15.0-17.0	246296	1	11.4			ML	A-4	IV
BB-BOHS-101, 6D	28+08.6	14.9 Lt.	25.0-27.0	246297	1	11.0			ML	A-4	IV
BB-BOHS-103, 2D	25+91.9	15.1 Lt.	5.0-7.0	246298	2	17.5			SM	A-4	III
BB-BOHS-103, 3D	25+91.9	15.1 Lt.	10.0-12.0	246299	2	12.3			SM	A-4	III
BB-BOHS-103, 4D	25+91.9	15.1 Lt.	15.0-17.0	246300	2	10.9			ML	A-4	IV
BB-BOHS-104, 1D	25+91.9	20.1 Rt.	5.0-7.0	246301	3	28.4			ML	A-4	IV
BB-BOHS-104, 2D	25+91.9	20.1 Rt.	10.0-12.0	246302	3	11.3			ML	A-4	IV
BB-BOHS-104, 4D	25+91.9	20.1 Rt.	20.0-22.0	246303	3	10.3			SM	A-4	III
BB-BOHS-105, 1D	26+87.3	36.5 Rt.	2.0-3.3	246304	4	4.9			SM	A-1-b	II
BB-BOHS-105, 2D	26+87.3	36.5 Rt.	8.3-10.3	246305	4	12.4			ML	A-4	IV
BB-BOHS-105, 3D	26+87.3	36.5 Rt.	15.0-16.4	246306	4	12.3			SM	A-4	III
BB-BOHS-106, 2D	28+05.3	21.8 Rt.	10.0-12.0	246307	5	11.1			SM	A-4	III
BB-BOHS-106, 3D	28+05.3	21.8 Rt.	15.0-17.0	246308	5	9.4			ML	A-4	IV
BB-BOHS-106, 4D	28+05.3	21.8 Rt.	20.0-22.0	246309	5	11.2			ML	A-4	IV
BB-BOHS-106, 6D	28+05.3	21.8 Rt.	30.0-32.0	246310	5	14.4			ML	A-4	IV

Classification of these soil samples is in accordance with AASHTO Classification System M-145-40. This classification is followed by the "Frost Susceptibility Rating" from zero (non-frost susceptible) to Class IV (highly frost susceptible). The "Frost Susceptibility Rating" is based upon the MaineDOT and Corps of Engineers Classification Systems.

GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

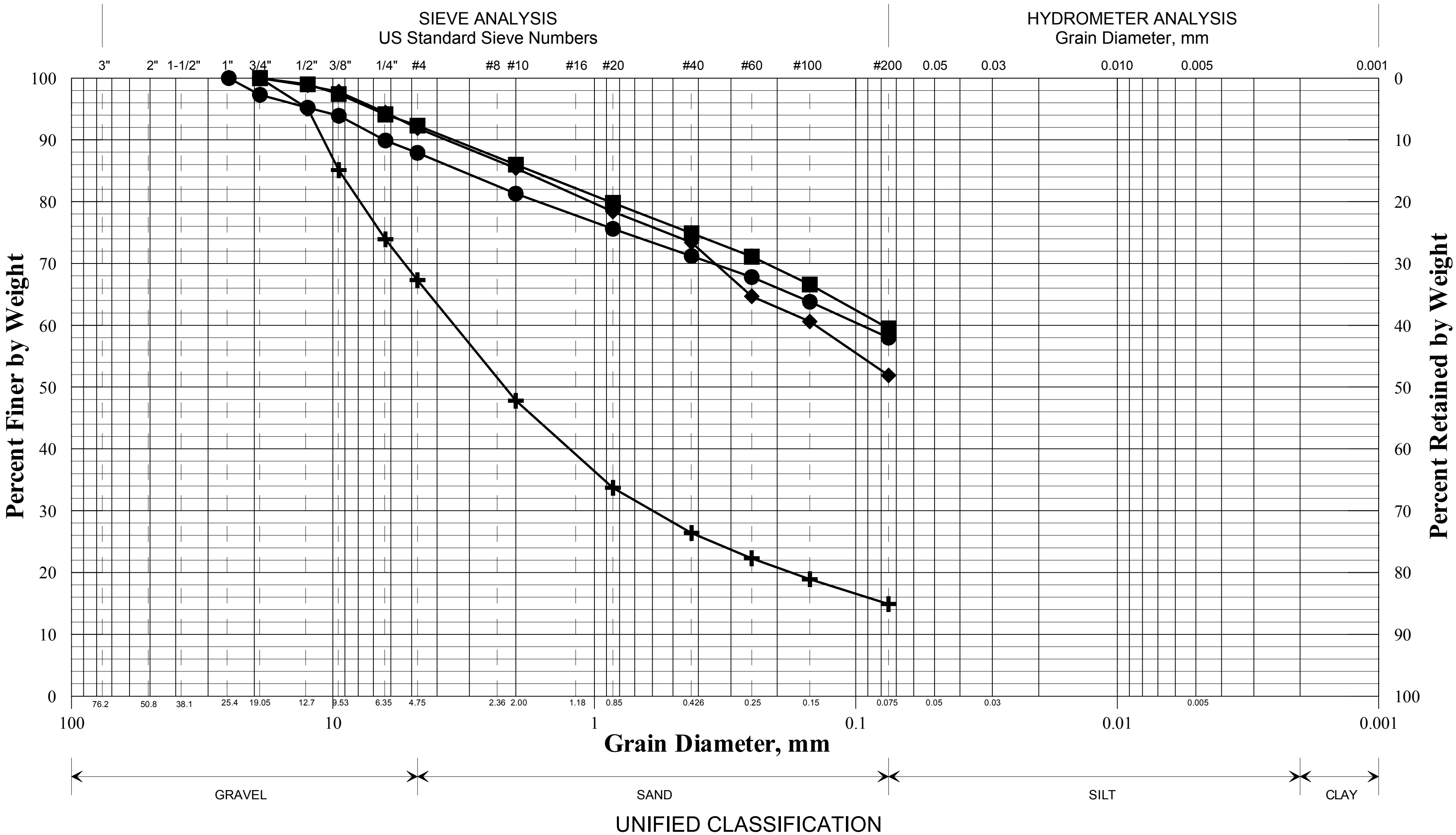
WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98

PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

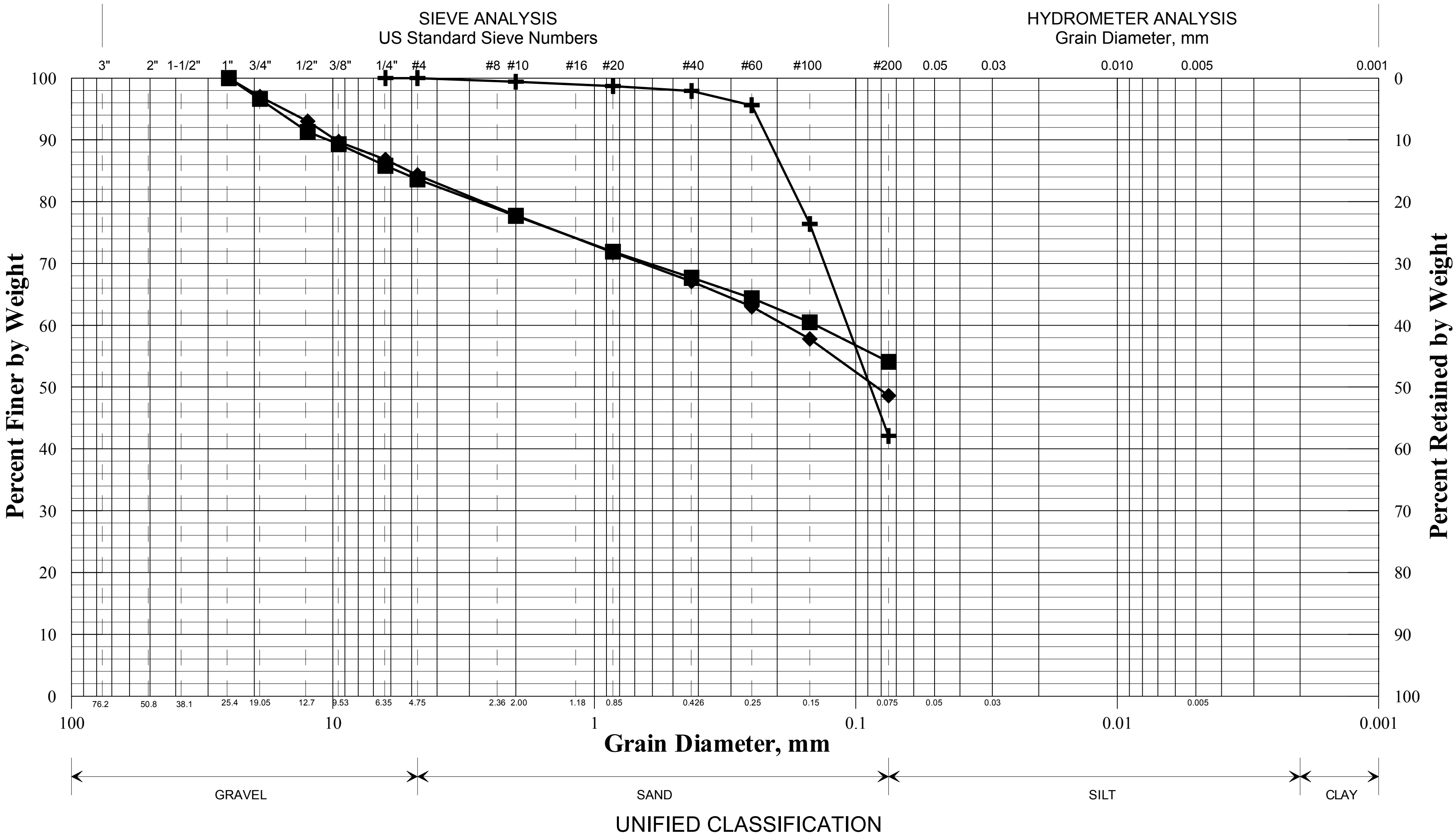


	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-BOHS-101/1D	28+08.6	14.9 LT	0.5-1.8	SAND, some gravel, little silt.	3.2			
◆	BB-BOHS-101/3D	28+08.6	14.9 LT	10.0-12.0	Sandy SILT, trace gravel.	19.8			
■	BB-BOHS-101/4D	28+08.6	14.9 LT	15.0-17.0	SILT, some sand, trace gravel.	11.4			
●	BB-BOHS-101/6D	28+08.6	14.9 LT	25.0-27.0	SILT, some sand, little gravel.	11.0			
▲									
✖									

PIN
016682.00
Town
Bangor
Reported by/Date
WHITE, TERRY A 8/27/2009

SHEET 1

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE

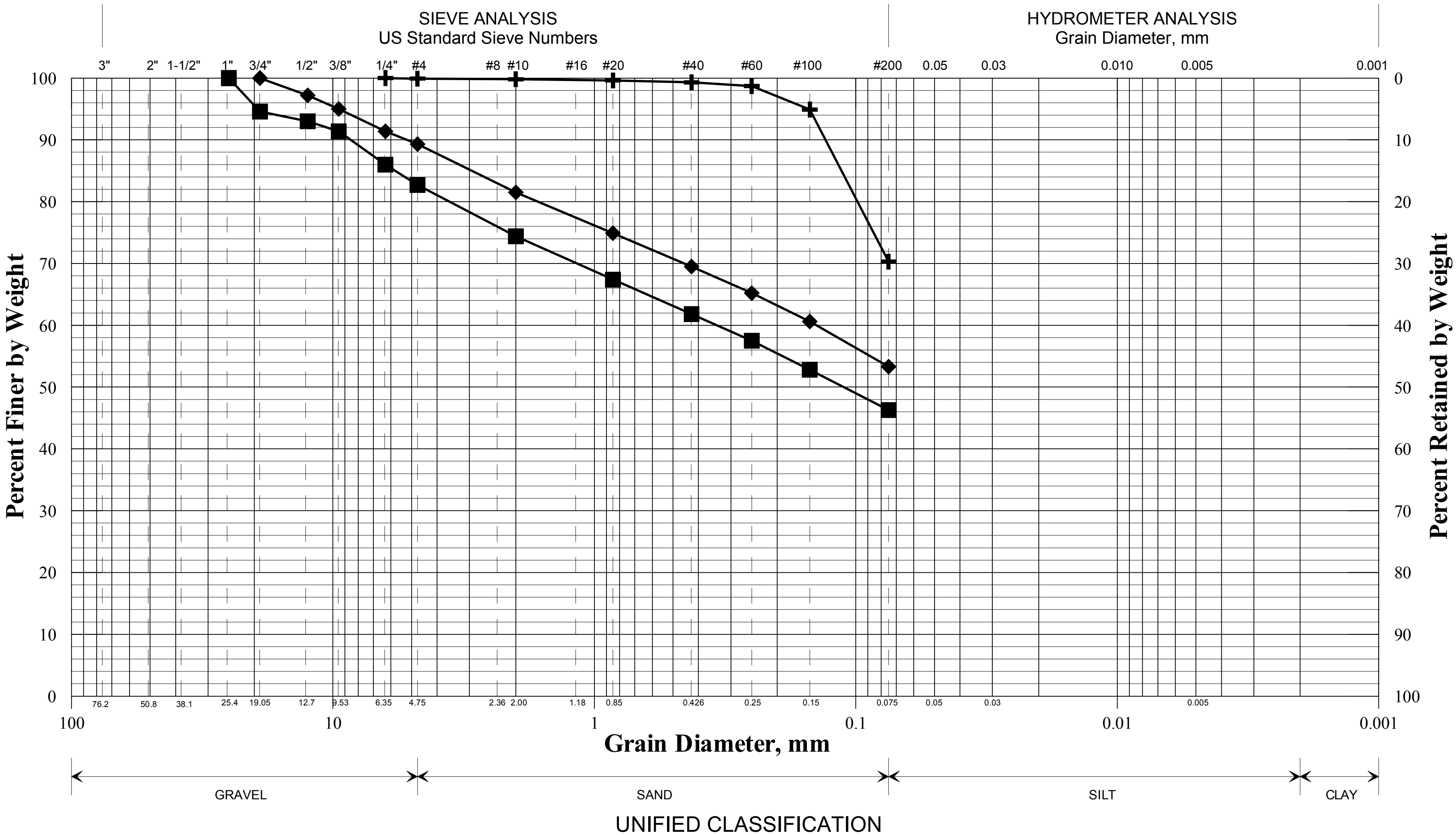


	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-BOHS-103/2D	25+91.9	15.1 LT	5.0-7.0	Silty SAND.	17.5			
◆	BB-BOHS-103/3D	25+91.9	15.1 LT	10.0-12.0	SILT, some sand, little gravel.	12.3			
■	BB-BOHS-103/4D	25+91.9	15.1 LT	15.0-17.0	SILT, some sand, little gravel.	10.9			
●									
▲									
✖									

PIN
016682.00
Town
Bangor
Reported by/Date
WHITE, TERRY A 8/27/2009

SHEET 2

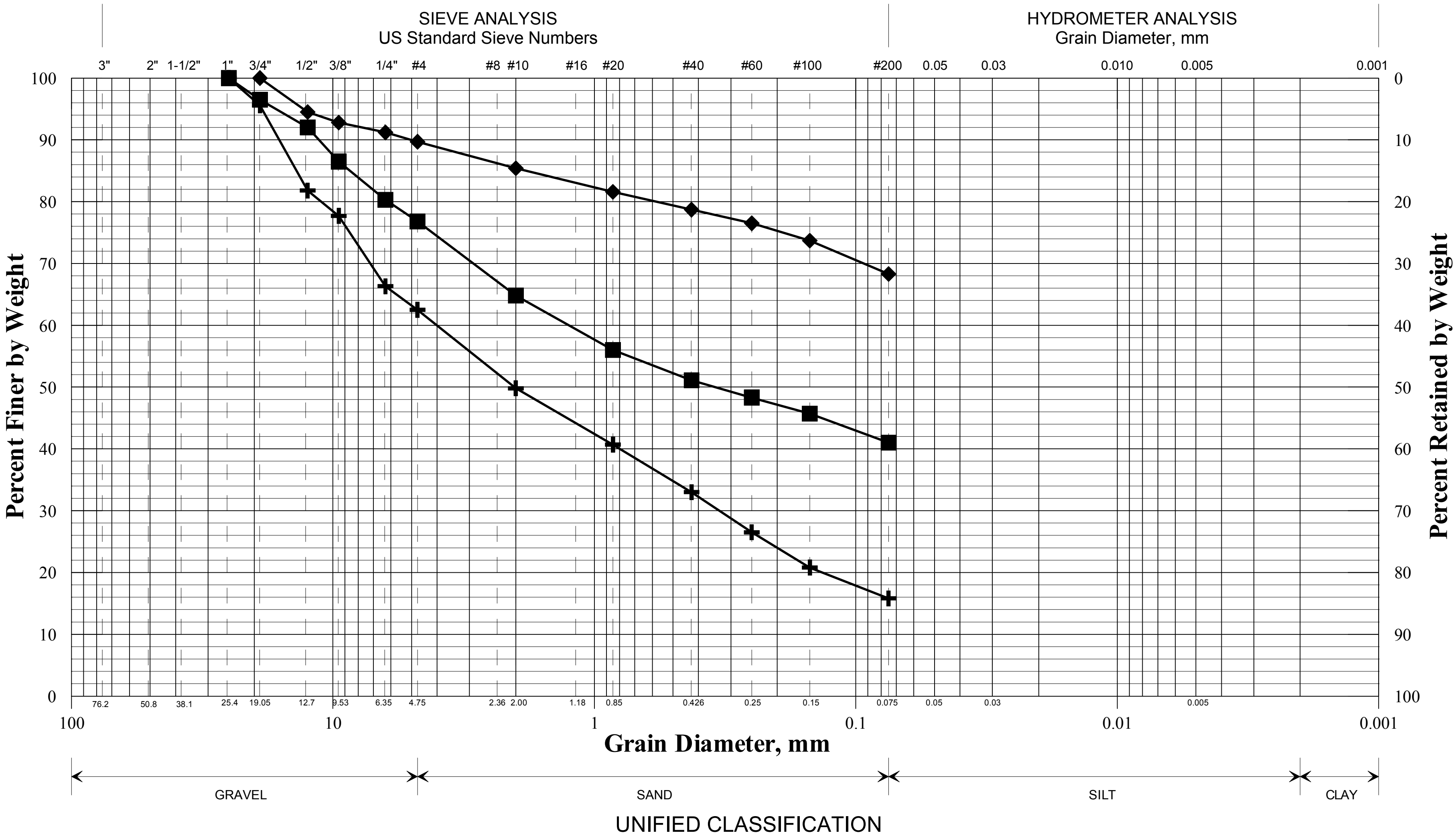
State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-BOHS-104/1D	25+91.9	20.1 RT	5.0-7.0	SILT, some sand, trace gravel.	28.4			
◆	BB-BOHS-104/2D	25+91.9	20.1 RT	10.0-12.0	Sandy SILT, little gravel.	11.3			
■	BB-BOHS-104/4D	25+91.9	20.1 RT	20.0-22.0	Sandy SILT, little gravel.	10.3			
●									
▲									
✖									

PIN
016682.00
Town
Bangor
Reported by/Date
WHITE, TERRY A 8/27/2009

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE

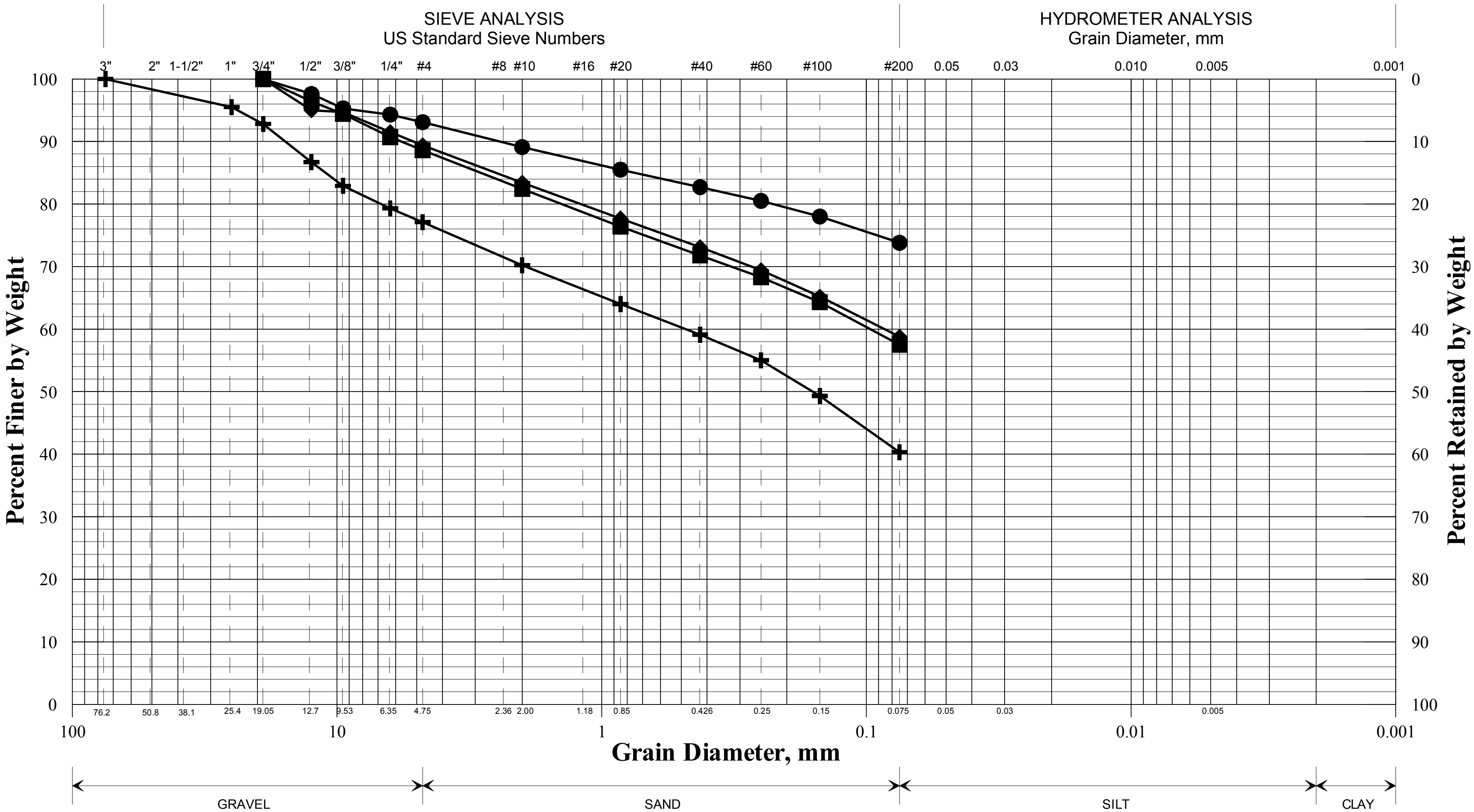


	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-BOHS-105/1D	26+87.3	36.5 RT	2.0-3.3	Gravelly SAND, little silt.	4.9			
◆	BB-BOHS-105/2D	26+87.3	36.5 RT	8.3-10.3	SILT, some sand, trace gravel.	12.4			
■	BB-BOHS-105/3D	26+87.3	36.5 RT	15.0-16.4	Sandy SILT, some gravel.	12.3			
●									
▲									
✖									

PIN
016682.00
Town
Bangor
Reported by/Date
WHITE, TERRY A 8/27/2009

SHEET 4

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-BOHS-106/2D	28+05.3	21.8 RT	10.0-12.0	Sandy SILT, some gravel.	11.1			
◆	BB-BOHS-106/3D	28+05.3	21.8 RT	15.0-17.0	SILT, some sand, little gravel.	9.4			
■	BB-BOHS-106/4D	28+05.3	21.8 RT	20.0-22.0	SILT, some sand, little gravel.	11.2			
●	BB-BOHS-106/6D	28+05.3	21.8 RT	30.0-32.0	SILT, little sand, trace gravel.	14.4			
▲									
✖									

PIN
016682.00
Town
Bangor
Reported by/Date
WHITE, TERRY A 8/27/2009

SHEET 5

Appendix C

Calculations

ABUTMENT AND WINGWALL ACTIVE AND PASSIVE EARTH PRESSURE:

Rankine Theory - Active Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.5.2, pg. 3-7

Either Rankine or Coulomb may be used for long-heeled cantilever walls where the failure surface is uninterrupted by the top of the wall stem. In general, use Rankine though.

Soil angle of internal friction: $\phi := 32deg$

Slope angle of backfill soil from horizontal: $\beta := 0deg$

$$K_a := \tan\left[45deg - \left(\frac{\phi}{2}\right)\right]^2$$

$K_a = 0.31$

Rankine Theory - Passive Earth Pressure from Bowles 5th Edition Section 11-5, pg 602

Soil angle of internal friction: $\phi := 32deg$

Slope angle of backfill soil from horizontal: $\beta := 0deg$

$$K_{p\_rank} := \frac{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}$$

$K_{p\_rank} = 3.25$

Coulomb Theory - Active Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.5.2, pg. 3-7

For gravity walls , semi-gravity walls, prefabricated modular walls, and cantilever walls and abutments with short heels where wall and backfill interface friction is considered, use Coulomb Theory

Angle of back face of wall: $\alpha := 90deg$

Soil angle of internal friction: $\phi := 32deg$

Slope angle of backfill soil from horizontal: $\beta := 0deg$

$\delta = \beta$ $\delta := \beta$

$$K_a := \frac{\sin(\alpha + \phi)^2}{\sin(\alpha)^2 \cdot \sin(\alpha - \delta) \cdot \left(1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - \beta)}{\sin(\alpha - \delta) \cdot \sin(\beta + \alpha)}}\right)^2}$$

$K_a = 0.31$

Coulomb Theory - Passive Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.6, pg. 3-8

Angle of back face of wall: $\alpha := 90deg$

Soil angle of internal friction: $\phi := 32deg$

Friction angle between fill and wall:
From LRFD Table 3.11.5.3-1, pg. 3-74, δ ranges from 17 to 22 $\delta := 20deg$

Angle of backfill from horizontal: $\beta := 0deg$

$$K_p := \frac{\sin(\alpha - \phi)^2}{\sin(\alpha)^2 \cdot \sin(\alpha + \delta) \cdot \left(1 - \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - \beta)}{\sin(\alpha - \delta) \cdot \sin(\beta + \alpha)}}\right)^2}$$

$K_p = 6.89$

FROST PROTECTION

Method 1:

From the Maine Design Freezing Index Map:
DFI = 1730 degree-days
Any Foundations Will Be Backfilled With Coarse-Grained Soils With Wn = 10%

From the 2003 Bridge Design Guide Table 5-1:

$Frost\_depth := [0.3 \cdot (90.1in - 87.5in) + 87.5in]$

$Frost\_depth = 88.28 \cdot in$

$Frost\_depth = 7.36 \cdot ft$

Method 2:

```
------------------------
--- ModBerg Results ---
-----------------------

Project Location: Orono, Maine

Air Design Freezing Index        =  1588 F-days
N-Factor                         =  0.80
Surface Design Freezing Index    =  1270 F-days
Mean Annual Temperature          =  43.5 deg F
Design Length of Freezing Season =  132 days

---------------------------------------------------------
Layer
#:Type             t    w%     d    Cf   Cu   Kf   Ku     L
---------------------------------------------------------
1-Coarse        77.4 10.0 125.0   28   34   2.0  1.6  1,800
---------------------------------------------------------

t  = Layer thickness, in inches.
w% = Moisture content, in percentage of dry density.
d  = Dry density, in lbs/cubic ft.
Cf = Heat Capacity of frozen phase, in BTU/(cubic ft degree F).
Cu = Heat Capacity of thawed phase, in BTU/(cubic ft degree F).
Kf = Thermal conductivity in frozen phase, in BTU/(ft hr degree).
Ku = Thermal conductivity in thawed phase, in BTU/(ft hr degree).
L  = Latent heat of fusion, in BTU / cubic ft.

*********************************************************
  Total Depth of Frost Penetration = 6.45 ft = 77.4 in.
*********************************************************
```

Use 6.5 feet

BEARING RESISTANCE ON COMPACTED FILL OR TILL SOILS:

SERVICE LIMIT STATE:

LRFD Table C10.6.2.6.1-1, Pg 10-66 (Based on NAVFAC DM 7.2) - "Presumptive Bearing Resistances for Spread Footing Foundations at the Service Limit State"

Bearing Material	Consistency in Place	Bearing Resistance (kips per sq. foot)	Recommended Value
Inorganic Silt, Sandy or Clayey Silt (ML, MH)	Very stiff to hard	4 to 8	6 ksf
	Medium stiff to stiff	2 to 6	3 ksf
	Loose	1 to 2	1 ksf

Recommend **Service Limit State** bearing resistance of **4.0 ksf** to control settlements and for preliminary footing sizing.

STRENGTH LIMIT STATE:

Nominal and Factored Bearing Resistance for spread footings on glacial till at the Strength Limit State:

Assumptions:

1. Footings will be embedded 6.5 feet for frost protection.

   $D_f := 6.5ft$

2. Assumed parameters for soils:
   Assume till

   Moist unit weight: $\gamma_m := 120pcf$

   Saturated unit weight: $\gamma_{sat} := 130pcf$

   Soil angle of internal friction: $\phi_{ns} := 34$

   Undrained shear strength (cohesion): $c_{ns} := 0psf$

3. Use Terzaghi strip equations as L > B

Depth to Groundwater table based on boring data: $D_w := 0 \cdot ft$

Unit weight of water: $\gamma_w := 62.4pcf$

Effective Stress at the footing bearing level:

$q_{eff\_str} := D_w \cdot \gamma_m + (D_f - D_w) \cdot (\gamma_{sat} - \gamma_w)$

$q_{eff\_str} = 0.44 \cdot ksf$

Assume footing width:

$$B := \begin{pmatrix} 10 \\ 12 \\ 14 \\ 16 \end{pmatrix} ft$$

Terzaghi Shape Factors from Table 4-1, p. 220
For strip footing:

$s_c := 1.0$

$s_\gamma := 1.0$

Meyerhof Bearing Capacity Factors For ϕ = 34 deg   Bowles 5th Ed. Table 4-4 pg. 223

$N_c := 42.14$ $N_q := 29.4$ $N_\gamma := 31.1$

Nominal Bearing Resistance per Terzaghi equation   Bowles 5th Ed. Table 4-1 pg. 220

$q_{nom} := c_{ns} \cdot N_c \cdot s_c + q_{eff\_str} \cdot N_q + 0.5(\gamma_{sat} - \gamma_w) \cdot B \cdot N_\gamma \cdot s_\gamma$

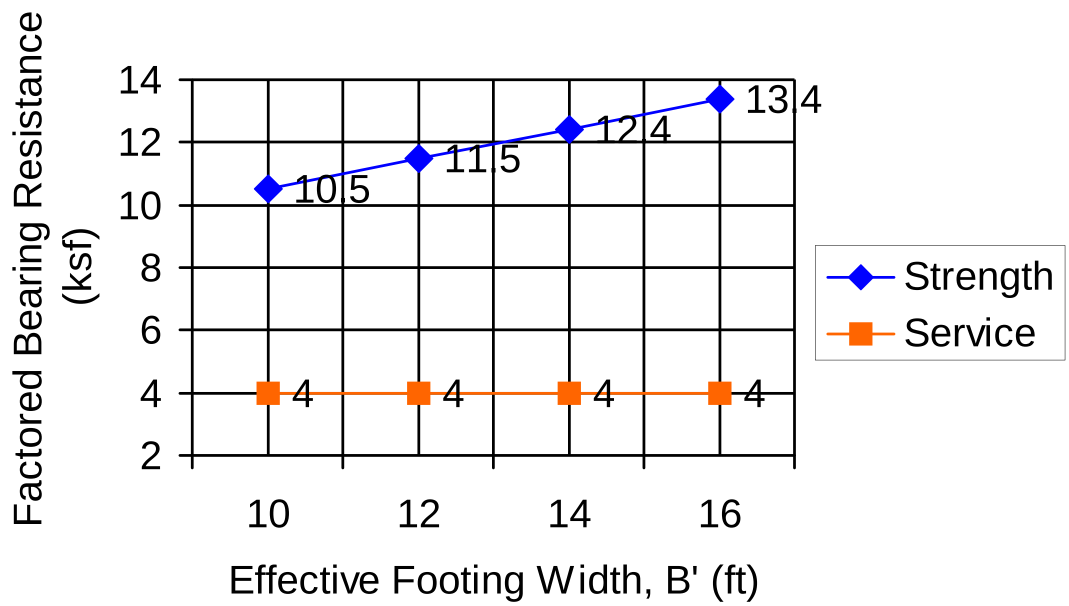
$$q_{nom} = \begin{pmatrix} 23.4 \\ 25.5 \\ 27.6 \\ 29.7 \end{pmatrix} \cdot ksf$$

Resistance Factor from LRFD Table 10.5.5.2.2-1 pg. 10-32: $\phi_b := 0.45$

$q_{fac} := q_{nom} \cdot \phi_b$

$$q_{fac} = \begin{pmatrix} 10.5 \\ 11.5 \\ 12.4 \\ 13.4 \end{pmatrix} \cdot ksf$$

The **Strength Limit State** Factored Bearing Resistances for Abutment and Pier Footings 10-16 feet wide.



EXTREME LIMIT STATE:

Nominal and Factored Bearing Resistance for spread footings on glacial till at the Extreme Limit State considering vehicle collison force CT:

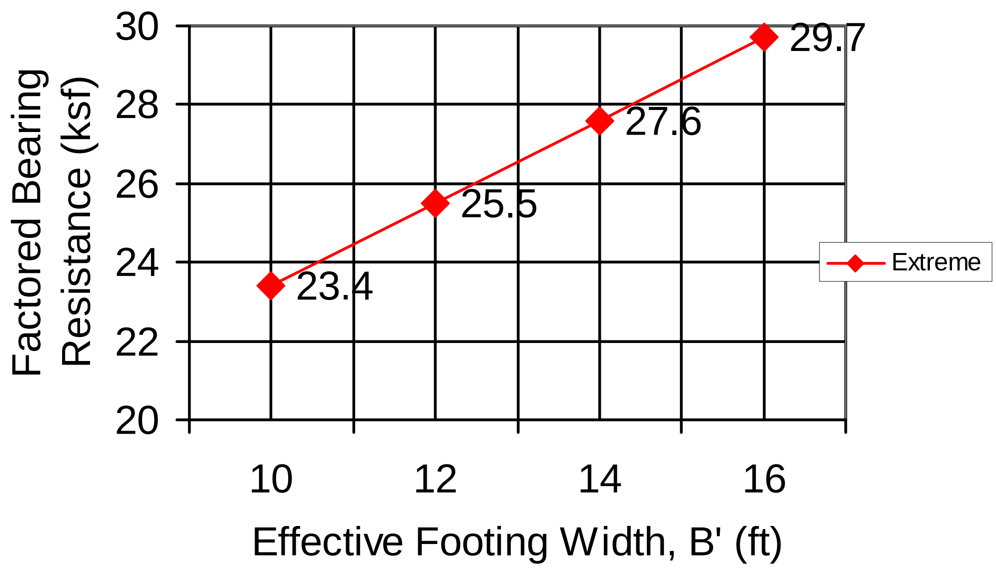
q_{nom} from above:

$$q_{nom} = \begin{pmatrix} 23.4 \\ 25.5 \\ 27.6 \\ 29.7 \end{pmatrix} \cdot ksf \quad \text{for} \quad B := \begin{pmatrix} 10 \\ 12 \\ 14 \\ 16 \end{pmatrix} ft$$

Resistance Factor from LRFD Table 3.4.1-1 pg. 3-13: $\phi_b := 1.0$

$$q_{fac} := q_{nom} \cdot \phi_b$$

$$q_{fac} = \begin{pmatrix} 23.4 \\ 25.5 \\ 27.6 \\ 29.7 \end{pmatrix} \cdot ksf \quad \text{for} \quad B := \begin{pmatrix} 10 \\ 12 \\ 14 \\ 16 \end{pmatrix} ft$$



SEISMIC EVALUATION:

Determine Site Class in Accordance with LRFD Section 3.10
Use N_{avg} Method, Table C3.10.3.1-1
Weakest Column has Most Soil: Use BB-BOHS-106

BB-BOHS-106

Depth	SPT N	Soil Type	di	di/SPT N
6	75	fill	3	0.04
6	30	fill	3	0.1
3	41	fill	2	0.04878
11	20	till	4	0.2
15	42	till	6.5	0.154762
20	28	till	5	0.178571
25	35	till	5	0.142857
30	43	till	5	0.116279
	100	bedrock	66.5	0.665
		SUM	100	1.64625
	N_{bar} =	**di/di/SPT N**		60.74411

N_{bar} > 50, Site Class C, LRFD Table 3.10.3.1-1, Pg. 3-85

The following parameters were determined for the site from the USGS Seismic Parameters CD provided with the LRFD Manual and LRFD Articles 3.10.3.1 and 3.10.6:

```
Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
AASHTO Spectrum for 7% PE in 75 years
 State - Maine
 Zip Code - 04401
 Zip Code Latitude   =   44.821200
 Zip Code Longitude  = -068.785700
 Site Class B
 Data are based on a 0.05 deg grid spacing.
   Period      Sa
   (sec)       (g)
    0.0       0.067   PGA - Site Class B
    0.2       0.146   Ss  - Site Class B
    1.0       0.044   S1  - Site Class B
```

```
Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
Spectral Response Accelerations SDs and SD1
 State - Maine
 Zip Code - 04401
 Zip Code Latitude   =   44.821200
 Zip Code Longitude  = -068.785700
 As = FpgaPGA, SDs = FaSs, and SD1 = FvS1
 Site Class C - Fpga = 1.20, Fa = 1.20, Fv = 1.70
 Data are based on a 0.05 deg grid spacing.
   Period      Sa
   (sec)       (g)
    0.0       0.081   As  - Site Class C
    0.2       0.175   SDs - Site Class C
    1.0       0.075   SD1 - Site Class C
```

SETTLEMENT ANALYSIS:

Settlement at Abutments and Pier, Granular Method 1:

Settlement at Abutments

Estimate Settlement for Footing On Soil Using Hough Method:
Ref. LRFD Section 10.6.2.4.2, pg. 10-56

Abutment 1 Assumptions Based on BB-BOHS-103, BB-BOHS-104:
1) Assume footing will be constructed 20 feet below ground surface (bgs) (~ 7ft below breastwall Finish Grade, +/-Elev. 111 ft)
2) No ground water observed; Assume ground water at footing base elev 111 ft
3) Soil depth below Abut 1 footing Elev 111 ranges from 2 to 9 ft - Use 9 ft (more settlement)
4) Use one 10 ft layer for settlement analysis per FHWA NHI-00-045, August 2000
5) Assume Footing Width = 12ft

SPT N_{60} values from BB-BOHS-103, and 104:

At 21 feet bgs: 33, 33 => $N_{60Avg} = 33$
At 26 feet bgs: 35 => $N_{60Avg} = 35$

$\gamma_t := 130pcf$ $\quad \gamma_w := 62.4pcf$ $\quad (\gamma') := \gamma_t - \gamma_w$ $\quad \gamma' = 67.6 \cdot pcf$

At 21 feet: $\sigma_{o1} := \gamma_t \cdot 20ft + \gamma' \cdot 1ft$ $\quad \sigma_{o1} = 2.67 \cdot ksf$ $\quad C_{N1} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o1}}\right)$

$C_{N1} = 0.91$ $\quad N1_{60Avg} := C_{N1} \cdot 33 = 30$

At 26 feet: $\sigma_{o2} := \gamma_t \cdot 20ft + \gamma' \cdot 6ft$ $\quad \sigma_{o2} = 3.01 \cdot ksf$ $\quad C_{N2} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o2}}\right)$

$C_{N2} = 0.87$ $\quad N1_{60Avg} := C_{N2} \cdot 35 = 30$

For Layer 1: $N1_{60Avg1} := \frac{(30 + 30)}{2} = 30$

Calculate Settlement

Use **Well Graded Silty Sand and Gravel** curve, Figure 10.6.2.4.2-1, pg 10-59

Layer 1: $N1_{60Avg1} = 30$ $\quad C'_1 := 102$

$z := 5ft$ $\quad H := 10 \cdot ft$ $\quad I := 0.8$ $\quad C' := 102$

$\Delta\sigma_v := 4ksf \cdot I$ $\quad \Delta\sigma_v = 3.2 \cdot ksf$

For Layer 1:

$\sigma_o := \gamma_t \cdot 20 \cdot ft + \gamma' \cdot z$

$\sigma_o = 2.94 \cdot ksf$

$$\Delta H := \overrightarrow{\left[H \cdot \left(\frac{1}{C'}\right) \cdot \log\left(\frac{\sigma_o + \Delta\sigma_v}{\sigma_o}\right)\right]} \qquad \Delta H = 0.37644 \cdot in$$

$\Delta H_{TOTAL} := 0.38 \cdot in$

Abutment 2 Assumptions Based on BB-BOHS-101, BB-BOHS-106:

1) Assume footing will be constructed 20 feet bgs (~ 7ft below breastwall Finish Grade, Elev. 113 ft)
2) No ground water observed; Assume ground water at footing base elev 113 ft
3) Soil depth below Abut 1 footing Elev 113 ranges from 9 to 14 ft - Use 14 ft (more settlement)
4) Use two 10 ft layers for settlement analysis per FHWA NHI-00-045, August 2000
5) Assume Footing Width = 12ft

SPT N_{60} values from BB-BOHS-101, and 106:

At 21 feet bgs: 46, 28 => $N_{60Avg} = 37$
At 26 feet bgs: 35, 35 => $N_{60Avg} = 35$
At 31 feet bgs: 43 => $N_{60Avg} = 43$

$\gamma_t := 130pcf$ $\gamma_w := 62.4pcf$ $(\gamma') := \gamma_t - \gamma_w$ $\gamma' = 67.6 \cdot pcf$

At 21 feet: $\sigma_{o1} := \gamma_t \cdot 20ft + \gamma' \cdot 1ft$ $\sigma_{o1} = 2.67 \cdot ksf$ $C_{N1} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o1}}\right)$

$C_{N1} = 0.91$ $N1_{60Avg} := C_{N1} \cdot 37 = 34$

At 26 feet: $\sigma_{o2} := \gamma_t \cdot 20ft + \gamma' \cdot 6ft$ $\sigma_{o2} = 3.01 \cdot ksf$ $C_{N2} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o2}}\right)$

$C_{N2} = 0.87$ $N1_{60Avg} := C_{N2} \cdot 35 = 30$

For Layer 1: $N1_{60Avg1} := \frac{(34 + 30)}{2} = 32$

At 31 feet: $\sigma_{o3} := \gamma_t \cdot 20ft + \gamma' \cdot 11ft$ $\sigma_{o3} = 3.34 \cdot ksf$ $C_{N3} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o3}}\right)$

$C_{N3} = 0.83$ $N1_{60Avg} := C_{N3} \cdot 43 = 36$

For Layer 2: $N1_{60Avg2} := 36$

Calculate Settlement

Use **Well Graded Silty Sand and Gravel** curve, Figure 10.6.2.4.2-1, pg 10-59

Layer 1: $N1_{60Avg1} = 32$ $C'_1 := 107$

Layer 2: $N1_{60Avg2} = 36$ $C'_2 := 120$

$z := \begin{pmatrix} 5 \\ 15 \end{pmatrix} ft$ $H := \begin{pmatrix} 10 \\ 10 \end{pmatrix} \cdot ft$ $I := \begin{pmatrix} 0.8 \\ 0.45 \end{pmatrix}$ $C' := \begin{pmatrix} 107 \\ 120 \end{pmatrix}$

$\Delta\sigma_v := 4ksf \cdot I$ $\Delta\sigma_v = \begin{pmatrix} 3.2 \\ 1.8 \end{pmatrix} \cdot ksf$

For the First Layer:

$$\sigma_o := \gamma_t \cdot 20ft + \gamma' \cdot z$$

Similarly:

$$\sigma_o = \begin{pmatrix} 2.94 \\ 3.61 \end{pmatrix} \cdot ksf$$

$$\Delta H := \overrightarrow{\left[H \cdot \left(\frac{1}{C'} \right) \cdot \log\left(\frac{\sigma_o + \Delta\sigma_v}{\sigma_o} \right) \right]} \qquad \Delta H = \begin{pmatrix} 0.35885 \\ 0.17553 \end{pmatrix} \cdot in$$

$$\Delta H_{TOTAL} := 0.36 \cdot in + 0.18 \cdot in$$

$$\Delta H_{TOTAL} = 0.54 \cdot in$$

Pier Assumptions Based on BB-BUS-102, BB-BUS-105:

1) Assume footing will be constructed ~ 7 feet bgs (~ Finish Grade, Elev. 103 ft)
2) Ground water at 6.5 ft
3) Soil depth below Pier footing Elev 103 ranges from 10 to 22 ft - Use 22 ft (more settlement)
4) Use one 10 ft layer and one 12 ft layer for settlement analysis
5) Assume Footing Width = 12ft

SPT N_{60} values from BB-BOHS-102 and 105:
Note: All SPTs from 102 are greater than 50 bpf, but could not advance spoon full 12 inches. Use N_{60} = 50

At 6 feet bgs: 50 => $N_{60Avg} = 50$
At 9 feet bgs: 24 => $N_{60Avg} = 24$
At 11 feet bgs: 50 => $N_{60Avg} = 50$
At 16 feet bgs: 50, 50 => $N_{60Avg} = 50$

$\gamma_t := 130pcf$ $\qquad \gamma_w := 62.4pcf$ $\qquad (\gamma') := \gamma_t - \gamma_w$ $\qquad \gamma' = 67.6 \cdot pcf$

At 6 feet: $\sigma_{o1} := \gamma_t \cdot 6ft$ $\qquad \sigma_{o1} = 0.78 \cdot ksf$ $\qquad C_{N1} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o1}} \right)$

$C_{N1} = 1.32$ $\qquad N1_{60Avg} := C_{N1} \cdot 50 = 66$

At 9 feet: $\sigma_{o2} := \gamma_t \cdot 6.5ft + \gamma' \cdot 2.5ft$ $\qquad \sigma_{o2} = 1.01 \cdot ksf$ $\qquad C_{N2} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o2}} \right)$

$C_{N2} = 1.23$ $\qquad N1_{60Avg} := C_{N2} \cdot 24 = 29$

At 11 feet: $\sigma_{o3} := \gamma_t \cdot 6.5ft + \gamma' \cdot 4.5ft$ $\quad \sigma_{o3} = 1.15 \cdot ksf$ $\quad C_{N2} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o3}}\right)$

$C_{N2} = 1.19$ $\quad N1_{60Avg} := C_{N2} \cdot 50 = 59$

For Layer 1: $N1_{60Avg1} := \frac{(66 + 29 + 59)}{3} = 51$

At 16 feet: $\sigma_{o4} := \gamma_t \cdot 6.5ft + \gamma' \cdot 9.5ft$ $\quad \sigma_{o4} = 1.49 \cdot ksf$ $\quad C_{N1} := 0.77 \cdot \log\left(\frac{40 \cdot ksf}{\sigma_{o4}}\right)$

$C_{N1} = 1.1$ $\quad N1_{60Avg} := C_{N1} \cdot 50 = 55$

For Layer 2: $N1_{60Avg2} := 55$

Calculate Settlement

Use **Well Graded Silty Sand and Gravel** curve, Figure 10.6.2.4.2-1, pg 10-59

Layer 1: $N1_{60Avg1} = 51$ $\quad C'_1 := 172$

Layer 2: $N1_{60Avg2} = 55$ $\quad C'_2 := 187$

$$z := \begin{pmatrix} 5 \\ 16 \end{pmatrix} ft \qquad H := \begin{pmatrix} 10 \\ 12 \end{pmatrix} \cdot ft \qquad I := \begin{pmatrix} 0.8 \\ 0.45 \end{pmatrix} \qquad C' := \begin{pmatrix} 172 \\ 187 \end{pmatrix}$$

$$\Delta\sigma_v := 4ksf \cdot I \qquad \Delta\sigma_v = \begin{pmatrix} 3.2 \\ 1.8 \end{pmatrix} \cdot ksf$$

For the First Layer:

$$\sigma_o := \gamma_t \cdot 6.5ft + \gamma' \cdot 0.5ft + \gamma' \cdot z$$

Similarly:

$$\sigma_o = \begin{pmatrix} 1.22 \\ 1.96 \end{pmatrix} \cdot ksf$$

$$\Delta H := \overrightarrow{\left[H \cdot \left(\frac{1}{C'}\right) \cdot \log\left(\frac{\sigma_o + \Delta\sigma_v}{\sigma_o}\right)\right]} \qquad \Delta H = \begin{pmatrix} 0.39062 \\ 0.21784 \end{pmatrix} \cdot in$$

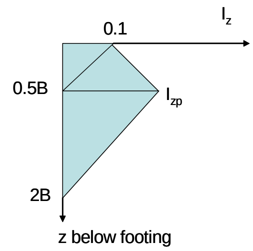
$$\Delta H_{TOTAL} := 0.39 \cdot in + 0.22 \cdot in$$

$$\Delta H_{TOTAL} = 0.61 \cdot in$$

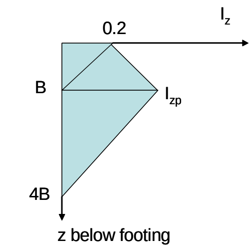
Settlement at Abutments and Pier, Granular Method 2:

Schmertmann's Method,
Foundation Engineering Handbook,
2nd Ed. p.179

$$S_e = C_1C_2(q_{contact} - q)\left[\sum (I_z/E_s) \times \Delta z\right]$$



Square Or Circular Footing



Rectangular Footing, For L/B > 10

E_s = 320 (N+15) kPa, Bowles 5th Edition, p.316
Estimate E_s based on lower end uncorrected N_{60} values from borings and 22 feet of till soil:
30 in upper layer 9.6 feet thick
35 in mid layer 7.2 feet thick
40 in lower layer 5.2 feet thick
Assume B = 12 feet

$N_{60} := \begin{pmatrix} 30 \\ 35 \\ 40 \end{pmatrix}$ $E_s := (N_{60} + 15)\cdot 320kPa$ $E_s = \begin{pmatrix} 301 \\ 334 \\ 368 \end{pmatrix}\cdot ksf$

$q_{allow} := 4ksf$ $B := 12ft$

$d := 6.5ft$ $\gamma := 130pcf$

$q := d\cdot\gamma$ $q = 845\cdot psf$

$C_1 := 1 - 0.5\cdot\left(\frac{q}{q_{allow} - q}\right)$ $C_1 = 0.87$

$C_2 := 1$ For all Maine Soils

Note: $\sigma'_{vp} = \gamma B$ for <u>Rectangular</u> and $\gamma 0.5B$ for <u>Square or Circular</u> Footing
This case:

$\sigma'_{vp} := \gamma\cdot B$ $\sigma'_{vp} = 1560\cdot psf$

$\Delta q := q_{allow} - q$ $\Delta q = 3155\cdot psf$

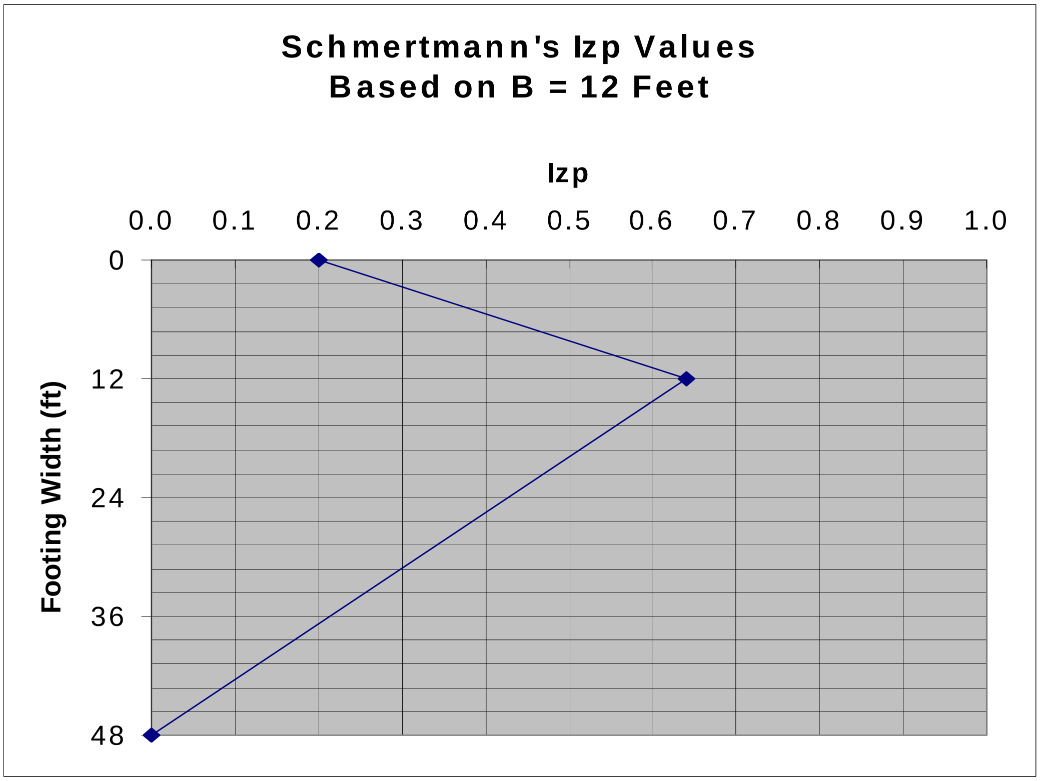
$I_{zp} := 0.5 + 0.1\cdot\sqrt{\frac{\Delta q}{\sigma'_{vp}}}$ $I_{zp} = 0.64$

Calculate $\sum (I_z/E_s) \times \Delta z$

Assume this project has average uniform E_s, L/B>10

Deepest soil column below any footing is 22 feet deep

Estimate Izp for layers based on chart below



$E_{s1} := 301\text{ksf}$ $\quad E_{s2} := 334\text{ksf}$ $\quad E_{s3} := 368\text{ksf}$

Layer 1 is 9.6 feet thick. At 9.6 feet, $I_{zp} = 0.55$

$$I_{z1} := \frac{0.2 + 0.55}{2} \qquad I_{z1} = 0.38 \qquad \Delta z1 := 9.6\text{ft} \qquad IzEs\Delta z_1 := \overrightarrow{\left(\frac{I_{z1}}{E_{s1}} \cdot \Delta z1\right)}$$

Layer 2 is 7.2 feet thick. 9.6 + 7.2/2 = 13.2 feet. At 13.2 feet, $I_{zp} = 0.62$

$$I_{z2} := 0.62 \qquad I_{z2} = 0.62 \qquad \Delta z2 := 7.2\text{ft} \qquad IzEs\Delta z_2 := \overrightarrow{\left(\frac{I_{z2}}{E_{s2}} \cdot \Delta z2\right)}$$

Layer 3 is 5.2 feet thick. At 16.8 feet, $I_{zp} = 0.56$. At 16.8 + 5.2 = 22.0 feet, $I_{zp} = 0.47$

$I_{z3} := \frac{(0.56 + 0.47)}{2}$ $I_{z3} = 0.52$ $\Delta z3 := 5.2ft$ $IzEs\Delta z_3 := \overrightarrow{\left(\frac{I_{z3}}{E_{s3}} \cdot \Delta z3\right)}$

$IzEs\Delta z_1 = 0.01 \cdot \frac{ft^3}{kip}$ $IzEs\Delta z_2 = 0.01 \cdot \frac{ft^3}{kip}$ $IzEs\Delta z_3 = 0.01 \cdot \frac{ft^3}{kip}$

Calculate Settlement

$$S_e := \left[C_1 \cdot C_2 \cdot \left(q_{allow} - q\right) \cdot \left(IzEs\Delta z_1 + IzEs\Delta z_2 + IzEs\Delta z_3\right)\right] \cdot 12 \frac{in}{ft}$$

$S_e = 1.07 \cdot in$

OK, Say immediate, elastic settlement below footing on soil will be on the order of 1 inch. Differential settlement will be on the order of 1/2 inch or less.